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SEAPAK User's Guide Version 2.0

Volume I--System Description

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Volume I--System Description

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Sections of this User's Guide may be revised periodically to reflect updates to the software.

FOREWORD

Over two years have passed since the publication of the SEAPAK Users Guide Version 1.0 (McClain et al., 1989). In that time, significant revisions to the CZCS and AVHRR support and statistical analysis programs have been made and the ancillary environmental data analysis module has been greatly expanded (Darzi et al., 1989; Firestone et al., 1990; Fu et al., 1990; Darzi et al., 1991; Firestone et al., 1991). SEAPAK now has about 200 procedures in the menu. The package continues to emphasize user-friendliness and user-interactive data analyses. In addition, because the scientific goals of the ocean color research being conducted have shifted to larger space and time scales, batch processing capabilities for both satellite and ancillary environmental data analyses have been enhanced, thus allowing large quantities of data to be ingested and analyzed in background (McClain et al., 1990).

The continued development of SEAPAK has been paralleled by three other activities that have influenced and assisted its growth. These are the global CZCS processing effort at NASA/Goddard Space Flight Center (GSFC), the collection of oceanographic datasets at the NASA Climate Data System (NCDS) at GSFC and the development of PC-SEAPAK. The global CZCS processing effort (Esaias et al., 1986; Feldman et al., 1989) was completed in March, 1990, and was a collaborative effort between Codes 936 and 971 at GSFC and the University of Miami. The quality control of the level-2 products was conducted by the ocean color investigators in Code 971 using the Oceans Computer Facility (OCF). Code 936 handled the routine ingest, processing, archival and distribution of the data. Investigators at the University of Miami Rosenstiel School for Marine and Atmospheric Sciences provided the processing software and the instrument calibration. SEAPAK incorporates the final instrument calibration and supports all levels of data available from the CZCS archive.

For the past four years, oceanographers at GSFC have been collaborating with NCDS to develop a comprehensive set of meteorological and hydrographic data. The strategy has been to coordinate their data requirements and consolidate the data collection at NCDS. This approach eliminates redundancy and provides a single source of data. Under this activity, over 30 major datasets from a number of national and foreign sources have been received, ingested, cataloged, inventoried and converted to the Common Data Format (CDF). Segments of each of these datasets have been copied in CDF form to the OCF where they are kept on optical and 8mm tape media. SEAPAK's ancillary environmental data analysis module can access all of these datasets, as well as a number of others, directly from optical or hard disk and process the data in the batch mode as well as in the user-interactive mode.

In late 1987, NASA/HQ requested a study be conducted to investigate the possibility of porting SEAPAK to a low-cost alternative configuration that emulated the original DEC VAX-based

version. The result is PC-SEAPAK. Versions 1 and 2 were released during 1989 to over 30 investigators. In September 1990, Version 3 (McClain et al., 1990a) was provided to the Computer Software Management and Information Center (COSMIC) at the University of Georgia for future distribution. Version 3 has nearly 100 procedures in the menu and is over 25MB in size. Version 4 will be released in 1991. The development of PC-SEAPAK has lead to many enhancements of the VAX-based SEAPAK software.

Finally, the next major development activity with SEAPAK will be to port it to a UNIX-based system where the hardware dependent components of the code will be replaced with software analogs. With the SeaWiFS project underway, SEAPAK's interoperability with the University of Miami's DSP will be expanded with many basic functions and formats being standardized. SEAPAK already has a close coupling to the General Meteorological Package (GEMPAK, desJardins et al., 1990) developed by the Severe Storms Branch at GSFC. Many procedures within the environmental data analysis module call routines from GEMPAK and the link between the two packages will be augmented and streamlined in the future.

The authors wish to thank the program managers at NASA HQ, past and present, who have provided support for the development of SEAPAK, namely Dr. Stan Wilson, Dr. Wayne Esaias, Dr. Curt Davis, Dr. Jim Yoder, Dr. Marlon Lewis and Dr. Greg Mitchell.

April 15, 1991
Charles R. McClain

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VOLUME II

DESCRIPTIONS OF PROGRAMS

INTRODUCTION

INTRODUCTION

SEAPAK is a user-interactive satellite data analysis package that has been developed at NASA/Goddard Space Flight Center (GSFC). Its primary applications are for the processing and interpretation of Nimbus-7/Coastal Zone Color Scanner (CZCS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR) data. It is similar in many respects to other analysis packages developed at NASA/GSFC such as the Landsat Analysis System (LAS) and the General Meteorological Package (GEMPAK) which employ the same hardware and user interface. As with all software packages, it constantly evolves as new capabilities and refinements are added. SEAPAK has not been developed for the sake of producing a large general analysis package and has never been supported as such. It is the product of the research programs of some of the scientists within the Laboratory for Hydrospheric Processes as supported by NASA/Headquarters. Its design and implementation is based on the conviction that all applications software developed should be available for use in a standardized format which provides flexibility and allows the user to truly work with the data. The system described in this document is SEAPAK as it exists in the NASA/GSFC Oceans Computer Facility (OCF). The structure of this manual is designed to be updated periodically, so sections are numbered independently of other sections and the manual is in a loose-leaf form. The manual includes sections which describe in some detail the various hardware and software components of the OCF relevant to SEAPAK, a number of data processing scenarios, an explanation of the SEAPAK menu and the programs it contains, a reference section containing detailed descriptions of all the SEAPAK programs, references and a glossary.

The CZCS was the first spaceborne sensor designed specifically to measure the concentration of photosynthetic pigments and their degradation products in the ocean. It had six co-registered bands (5 visible and one in the thermal IR) with a swath and resolution (2200 km and 825 meters at nadir, respectively) similar to the NOAA AVHRR. The CZCS IR band did not work after about the first year and was only useful for thermal feature delineation when it did work. The derived products generated by the CZCS level 2 programs are upwelled water radiance at 443, 520 and 550 nm, aerosol radiance at 670 nm, pigment concentration and Rayleigh radiance at 443 nm. A variety of programs have been developed which allow the user to derive and evaluate the input parameters required by the level-2 generation programs.

Since sea surface temperature (SST) is an important oceanographic parameter, a capability for handling SST fields from the AVHRR was developed. Many of the analysis tools developed for the CZCS derived product fields are also useful in analyzing SST fields. The algorithm for calculating the SST values from the AVHRR brightness temperatures varies depending on the satellite (TIROS-N or NOAA-6, 7, 8, 9, 10, 11). SEAPAK supports most of the

SST algorithms that have been published for different satellites. In addition, SEAPAK also allows the user to enter coefficients for a generalized SST equation.

The SEAPAK code has been developed in Fortran-77 for the Digital Equipment Corporation VAX line of CPU's and uses the International Imaging Systems (IIS) Model 75 (512x512 pixel display) as the display system with the IIS System 575 software. Some applications programs do call subroutines from the IMSL library of statistical functions which is licensed on the OCF. The user interface is the Transportable Applications Executive (TAE) which has also been developed by NASA and is written in the C language. The interface is menu driven with on-line help on all programs and input parameters.

SEAPAK is organized into several categories of programs in the menu which include tape ingest, CZCS level-2 analyses, statistical analyses, data extraction, mapping to standard projections, IIS graphics plane manipulation, IIS refresh memory manipulation, general utilities, University of Miami DSP file format conversions and ancillary environmental data analyses. Some of the Miami DSP file format conversion programs call DSP subroutines which are resident on the OCF by arrangement with the group at the University of Miami who have developed and maintain it. Most programs allow user interaction not only through the TAE menu, command and tutor modes, but also allow the user to work within a program by using the IIS trackball cursor to define pixels or areas of interest and the IIS keypad from which subprocesses may be executed in any order and any number of times without exiting the main program. Hardcopy support includes a Matrix model 4007 camera and DICOMED tape output for image data, a Hewlett Packard 7550A plotter for line plots and a system line printer for listings. Most programs also provide for ASCII file generation for further analysis in spreadsheets, graphics packages, etc.

The ancillary environmental analysis module includes support for meteorological and hydrographic data. These data may be gridded fields or random station data. The gridded fields are in the Common Data Format (CDF) developed by the National Space Science Data Center (NSSDC). Random station data such as CTD or hydrocast data is indexed and placed in master data files which may be queried by space, time, depth and parameter. The analysis of meteorological data is facilitated by utilizing GEMPAK. GEMPAK is maintained on the OCF by the scientists in the GSFC Severe Storms Branch who developed it. GEMPAK can be accessed either directly through the menu system or indirectly by using SEAPAK programs which call GEMPAK and GEMPLT subroutines.

Finally, SEAPAK has been ported to a personal computer-based image analysis system called PC-SEAPAK with support provided by NASA/Headquarters (McClain et al., 1990a). The purpose of this activity is to develop a low-cost system which emulates the VAX/IIS SEAPAK image analysis system. The hardware for this system can be easily acquired from commercial sources and PC-SEAPAK is available from NASA. This system does incorporate and even enhance the user friendliness, flexibility and versatility of the VAX/IIS system.

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For more information, contact Dr. Charles R. McClain, Code 971, NASA/GSFC, Greenbelt, MD 20771, or call at 301-286-5377.

Obtaining CZCS Data: The following types of CZCS data may be obtained from the CZCS archive at NASA/GSFC (Feldman et al., 1989):

- Level 1 Full resolution, swath projection (unmapped), calibrated radiance data for all six CZCS bands in a single scene.
- Level 1b Subsampled (every fourth pixel and line) level-1 data for bands 1 to 5; about 4km resolution.
- Level 2 Derived geophysical parameters for a single, unmapped CZCS scene at 4km resolution.
- Level 3 Level-2 composited, Earth-gridded (binned) data.

Format options for these products are summarized in Table 1.

In order to evaluate CZCS coverage, a browse capability has been developed which includes (1) software that allows the user to query a data base using a number of parameters including latitude and longitude ranges and time interval to determine the scenes available which satisfy the query criteria and (2) a set of 3 Panasonic video disks which contain all the CZCS pigment images. The browse software can be used with or without the Panasonic player and versions are available for a variety of machines including VAX and PC-AT compatibles. The advantage of using the Panasonic video player is that each image that satisfies the query is displayed and the user has the option of ordering the displayed scene before progressing to the next scene.

Orders to the archive can be initiated from within the browse session provided the system is a SPAN node. Data requests may also be filed through OMNET. Comments regarding format specification and requirements should be included with any request. For information about the CZCS archive, contact Gene Feldman, Code 636, NASA/GSFC, Greenbelt, MD 20771 (tel., 301-286-9428; OMNET, G.FELDMAN; SPAN, MANONO::GENE). The browse package is available at no charge.

Obtaining AVHRR Data: To obtain NOAA AVHRR level-1b data, contact Will Gould, Room 100, NOAA/Satellite Data Service Division, Princeton Executive Center, Washington, DC 20233 (tel., 202-763-8400). Also, one should refer to Brown et al. (1985), Kidwell (1988), and Planet (1988) regarding AVHRR data formats and calibration.

Table 1. Data formats available for 9-track and 8mm tapes.

<u>Format</u>	<u>Data</u>	<u>Procedure to Create Tape under VAX/VMS</u>
CRT	Level 1	Special program
VAX backup	Levels 1,1b,2,3	BACKUP command
Archive foreign	Levels 1,1b,2,3	MOUNT/FOREIGN and COPY
Archive labeled	Levels 1,1b,2,3	MOUNT/LABEL and COPY

SYSTEM ENVIRONMENT

- A. Hardware**
- B. Software**
- C. Optical Drive and Juke Manager**

SYSTEM ENVIRONMENT: HARDWARE

SYSTEM CONFIGURATION

The general configuration of the Laboratory for Hydrospheric Processes' Oceans Computer Facility (OCF) is shown in Figure 1. There are four CPUs which are connected via a Local Area VAX Cluster (LAVC). The LAVC utilizes the local DECNET network to effect the clustering and a DECNET interface board is installed on each CPU. DECNET is a specific network protocol which uses the Ethernet lines. Other protocols are supported on the Ethernet system such as TCP/IP, but require special interface hardware as well and are not supported on the OCF. The CPUs are one VAX 11/750 (node name OCEAN1) and three MicroVAX-IIs (node names OCEAN2, DIATOM and URCHIN). OCEAN1 serves as the central component of the cluster in that the two IIS Model 75s, the IIS IVAS, all 9-track tape drives and the 8-mm tape drive are connected to it. The 9-track and 8-mm tape drives can only be accessed through OCEAN1. All IIS image workstations are dual-ported to OCEAN1 and to one of the MicroVAXs. The MicroVAXs serve as the principal CPUs for image analysis while the VAX 11/750 serves as a backup whenever a MicroVAX is not available for use. The reason for this is that routine tape and batch operations severely impede the response of the CPU and, therefore, can greatly decrease the efficiency of users working interactively on the image workstations. For this reason, users are encouraged to execute CPU-intensive jobs in batch at night or on OCEAN1. SEAPAK is available on all CPUs and access requires that a symbol be defined in the user's LOGIN.COM file.

The LAVC also provides for access to all disk drives on the system from any of the CPUs. Some disk drives are connected directly to certain CPUs, but some are not. For instance, the four CDC SCSI disk drives are directly connected to DIATOM and URCHIN only, but may still be accessed from OCEAN1 and OCEAN2 via the LAVC. This difference is transparent to the user and is manifested only by a somewhat slower data transfer rate. In addition to the respective system drives, the only drives not available to all CPUs are the SONY optical disk drives which is dedicated to DIATOM. This is because the controller can only support two CPUs and also because the driver for the optical drives is imbedded in the University of Miami DSP system which uses DIATOM almost exclusively (some functions run on OCEAN1). Note that the Adage image display system is also connected only to DIATOM for the same reasons.

VMS has four categories of disk file operation privilege which are read, write, execute and delete, each of which is determined by the class the user is in (user, group, world, system). This is possible because each file has an owner (user) attached to it and users can be organized into groups such as "color" which contains all users associated with the ocean color investigators. Therefore, access and manipulation of files depends on the operation one wants to perform, the privileges defined for the

particular disk file and the group (if any) definition. Also, each disk will have user accounts with space quotas defined which determine whether or not a user can create files on the disk under his user ID. Only the system manager has SYSTEM privileges and is the only individual who can actually create accounts and quotas on the CPUs and the disk drives.

The OCF has been designed to accommodate group-dedicated hardware systems which allow for any group of users who have obtained funding for hardware to integrate hardware into the system yet maintain control of its use. The privilege to add hardware is overseen by the OCF Users Committee and the system manager. The committee and the system manager work together to ensure that proposed additions to the system have no adverse effects on the system and that the hardware is compatible with the existing system. They also offer advice on hardware selection. This arrangement is unusual but necessary because it is essential that certain resources such as tape drives be available to everyone, but, at the same time, research programs funded for specific tasks should be able to execute their research with minimal interference from other users. The typical arrangement is that other users may use certain group-specific hardware such as workstations on a non-interference basis. An example is the ocean color hardware which includes URCHIN, DIATOM, the SI disk drives, the CDC SCSI disk drives, the SONY optical drives, the Adage display system, the HP plotter and one of the IIS Model 75 display systems. The color investigators determine the allocation of accounts on these MicroVAXs and on these disk drives, but allow other users access to the display systems whenever they are not being used.

SEAPAK uses only the IIS Model 75s as its image display systems. These are identified in the SEAPAK software as ATLANTIC, owned by the ocean color group, and PACIFIC which is owned by the Laboratory for Hydrospheric Processes. Since PACIFIC is available to all users, time on it is scheduled although users can work on it anytime the scheduled user is not using it. ATLANTIC is not scheduled.

Hardcopy of SEAPAK data products is supported with the Matrix camera which is connected to the monitors cabled to ATLANTIC and PACIFIC. The Model 75s are actually located in the main computer room. The Matrix and the monitors are coupled through a main switch box next to the camera. The Matrix accommodates 8x10 color polaroids and transparencies and 35mm prints and slides. The format of the Matrix is controlled using the buttons on the front panel which allows the user to select the number of frames to be exposed on each shot. SEAPAK also supports DICOMED tape generation using the DICOMED program in the SEAPAK menu. Numerous SEAPAK programs support output to the HP plotter. The plotter is configured on OCEAN1 as a queued device meaning that jobs are stacked in a sequence and sent to the plotter as it finishes the current job or as it becomes available.

Maintenance and support of all the OCF equipment is provided by NASA/Headquarters under an RTOP grant to the Chairman of the OCF Users Committee. The Chairman position is rotated annually among

the scientists in the Laboratory for Hydrospheric Processes. Each year the committee and the system manager prepare a budget for maintenance and any hardware users feel are needed. Hardware requests are identified with the particular individual or group proposing the purchase. Some hardware requests are from the committee/system manager for the use by all users or for upgrading or replacing existing equipment. NASA/Headquarters reviews the proposals and determines what will be supported.

THE IIS MODEL 75

SEAPAK runs with an International Imaging Systems (IIS) Model 75 (M75) Image Processor (International Imaging Systems, 1983) for image display and for many of its image processing functions. There are two identical M75 processors in the OCF which have the same features as described below.

Display: The display size is 512x512 pixels by 8 bits per pixel. The display monitor used is a Mitsubishi monitor. The display is 60 Hz, interlaced.

Refresh Memory: There are sixteen refresh memory channels each containing 512x512 pixels by 8 bits per pixel. Two refresh memory channels are packaged on a single printed circuit board. Thus, there are eight "channel-pairs" corresponding to the sixteen refresh memory channels. The eighth (or the graphics) "channel-pair" is reserved for the graphics data. An independent scroll feature and an independent replicative zoom feature are provided for each channel-pair. The two channels in a channel-pair is better understood by thinking of one as the foreground channel and the other as the background channel. The foreground channel and the background channel are mutually exclusive as far as the video data stream output is concerned; i.e., only the foreground channel can be used. Switching between the foreground channel and the background channel can be achieved through the scroll feature. However, the scroll, the zoom and the look-up table (described below) functions which apply to the foreground channel also affect the background channel. For example, if the foreground image is pseudo-colored with certain look-up tables, the same color scheme remains when the display is switched to the background image. As a matter of fact, a channel-pair can be thought of as a 1024x512x8 bit image memory. By use of the scroll feature, any contiguous 512x512 subsection from this 1024x512 scene may be configured for display.

Due to this channel-pair configuration, certain SEAPAK functions prohibit the use of the channels from the same channel-pair as mentioned in the program description sections. The channels in SEAPAK are numbered 1 to 14 for image data and the other two are reserved for graphics data. Channels are paired as follows: 1-8 (Channels 1 and 8 are a pair), 2-9, 3-10, 4-11, 5-12, 6-13 and 7-14.

Input Function Memory: The input function memory (IFM) is a programmable look-up table that is applied to the data on its way to the refresh memory. By use of the IFM, image data of magnitude up to 12 bits can be transformed to numbers of eight bits or less. The IFM may be bypassed so as to have no effect.

Pipeline: Three parallel pipelines are provided to perform array arithmetic for each of the three primary colors, red, green and blue (RGB). Any refresh memory channel-pair or combination of refresh memory channel-pairs can be assigned to any of the three pipelines, which, in turn, supply the RGB primary color outputs to the display. Each pipeline contains hardware split screen, eight independent look-up tables (one for each of the refresh memory channel pair), an adder array, minimum-maximum, range and constant function, and an output function memory.

The pipelines provide basic arithmetic capabilities such as addition, subtraction, multiplication, division, logarithms and exponentiation at the 30 times per second per operation rate between the 512x512 pixel arrays stored in the refresh memory or memories. The basic arithmetic is performed among displayed images with display units (or so called gray levels); no real number operations can be performed.

Look-Up Tables: Eight 1024x12-bit look-up tables (LUTs) are provided in each pipeline, one for each refresh memory channel-pair. A total of 24 LUTs exist in the M75, eight for each of the red, green and blue colors. Twelve-bit numbers are stored in the LUTs to provide better dynamic range for multiply and divide functions. The output data stream from each LUT can be selectively enabled/disabled; hence complete combinatorial flexibility is provided in assigning image bands to primary colors. For example, pseudo-coloring a single band image is done by enabling the red, green and blue LUTs of a particular refresh memory channel-pair where the single band image resides. On the other hand, true coloring (or false-coloring) of a three band image is done by enabling the red LUT, the green LUT and the blue LUT from three different refresh memory channel-pairs. The latter is an example of how loading images into refresh memories should be done with caution because the three bands of the image should be loaded into different "channel-pairs," else the true coloring can not be performed.

Each of the 1024x12-bit LUTs can be considered as four separate 256x12-bit LUTs. Eight bits on input to the LUTs are supplied by the refresh memory channel-pairs while the other two are supplied by the regions of interest (ROI or "blotched" area) stored in the graphics memory. Thus, LUT operations on the ROIs can be performed.

Adder Array: This array takes the two's complement sum of the LUT outputs. Subtraction (and division via logarithm) can be accomplished due to the two's complement sum feature. Each pipeline contains an adder array.

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Output Function Memory: Each pipeline contains an output function memory (OFM) which transforms the outputs of the range registers (described below) to generate the final red, green and blue data stream. Each OFM consists of a 10-bit in, 12-bit out look-up table. Twelve bits of resolution at the output is required for the feedback function.

Min-Max Registers: The min-max registers examine the 12-bit data stream as it merges from the adder array and determines the dynamic range of the data by finding the minimum and maximum pixel values within the 512x512-pixel array. The min-max values are used in determining the setting of the range registers (described below) to process the desired 10 bits (out of the 12-bit adder array) via the OFM.

Range and Constant Registers: The range registers are used to reduce the 12-bit data stream from the adder array to 10-bit stream for application to the OFM. The range registers allow selection of 10 contiguous bits of bits 0 through 9 or bits 1 through 10 or bits 2 through 11. The constant registers provide for the addition or subtraction of a 12-bit constant from the data stream before it is applied to the range registers.

Zoom: The zoom feature allows magnification via pixel replication of the displayed image by a factor of 2, 4 or 8 around an arbitrary location within a refresh memory channel-pair. Each refresh memory channel-pair contains its own zoom control. Within a channel-pair, the X (pixel direction) and Y (line direction) zoom factors can be independently set.

Scroll: Each refresh memory channel-pair contains independent X and Y scroll capabilities. Refer to the refresh memory subsection above for more information.

Split Screen: Split screen provides the capability of splitting the display space into four equal or unequal quadrants around an arbitrary location. Each quadrant can be supplied by any area of any refresh memory channel-pair. By using split screen, roaming of a 2048x2048 pixel image (which resides in 8 refresh memory channel-pairs) with a display window of 512x512 can be performed.

Graphics: Eight 512x512x1-bit graphics planes can be provided in the M75. The eighth refresh memory channel-pair is used for the graphics data. Either channel in the graphics memory channel-pair can provide eight graphics planes. Since only one graphics memory channel can be displayed at one time, only the background channel is used in SEAPAK for graphics. Non-destructive and destructive graphics overlay is provided. The eighth graphics plane of the graphics memory channel is reserved in SEAPAK to display the button selection menu which drives the status D/A converter. A foot pedal is provided to switch the regular display which is output from the pipeline to the status (button menu) display.

Cursor: The cursor RAM is a 64x64x1-bit memory. The shape of the cursor can be defined and stored in the RAM. The color and display (on, off, blinking) of the cursor can also be programmed. The position of the cursor can be controlled by the host computer or by the trackball (described below).

Trackball: The trackball is used to control the cursor location. In addition, fifteen function buttons are provided on the trackball housing. Each function button is programmable to control program flows. When the button is pushed and an interrupt is received by the program, a "beep" sound will be generated. The trackball unit also provides four buttons to explicitly move the cursor one pixel increment in the up/down or left/right direction. There is also a "rate" selection switch which provides four rates of cursor movement relative to a single rotation of the trackball.

Graphics Color Assignment: The eight bit output from the graphics memory and the one bit output from the cursor forms a 9-bit data stream to be assigned with proper color through the graphics color assignment function memory. This memory has 512 locations of 16 bits each. The 512 locations correspond to the 9-bit data stream. The 16-bit field defines red color component (5 bits), green color component (5 bits), blue color component (5 bits) and a replace/add mode (1 bit) for the graphics overlay. That is, destructive overlay can be done with the replace mode while the non-destructive overlay can be done with the add mode.

Videometer: The videometer is a processing element that computes the histogram at the output of the pipeline. The histogram of the entire display or only blotched regions can be generated.

Feedback-Arithmetic/Logic Unit: The feedback-arithmetic/logic unit allows the retention of output from OFM of pipeline to be captured in a different refresh memory channel (via IFM if desired) in a single frame of time. In addition, two different arithmetic or logical operations can take place during the same feedback cycle. The arithmetic or logical operations can be performed in the entire display or within blotched area. During the feedback cycle, the 12-bit output from any of the three pipelines is converted to 8-bit data and stored in the destination refresh memory channel.

MISCELLANEOUS HARDWARE

Hewlett Packard 7550A Plotter: This device provides a means for obtaining high-quality multicolor hardcopy of X/Y plots and map overlays generated by certain SEAPAK programs. X/Y plots generated by programs like RLINE, VARIOG, EOFLOT, XCORR, TSERIES, HIST, MEM and TIMENV can be output. Map overlays, including contours, annotation, grids and wind vectors can be output by the program GEMPLOT. The HP 7550A device driver from GEMPAK (described in the software chapter) is used to communicate with the plotter. This

device driver translates the user's request into a series of HP-GL (Hewlett Packard Graphics Language) commands for drawing the vector graphics in the appropriate colors and plot region on whatever medium is loaded. Therefore it is necessary to have a copy of GEMPAK on your system if you plan to purchase an HP 7550A plotter for use with SEAPAK. GEMPAK can be obtained from NASA's COSMIC software library. An RS-232-C cable interface connects the HP 7550A with the VAX 11/750 host computer. Other computers which support an RS-232-C (e.g. HP 150, HP Vectra, HP 3000, HP 9000-series 200, HP 9000-series 500, Apple II Plus, Apple IIe, IBM PC-XT, IBM PC-AT) or HP-IB (e.g. HP 120/125, HP 150, HP 9000-series 500) interface could be connected to the HP 7550A as well.

The plotter supports output to five different media types: chart paper, glossy presentation paper, overhead transparency film, vellum, and double-matte polyester film, in either ANSI A (8.5x11 inches) or B (11x17 inches), or ISO A4 (210x297 mm) or A3 (297x420 mm) sizes. Four different types of carousels are available to support the use of paper pens, transparency pens, roller-ball pens, and drafting pens (refillable or disposable). The carousels can hold up to eight pens of different colors (ten are available) and/or tip thicknesses. The force and speed with which these pens will plot is fully adjustable from the HP's LED control panel. Other features which can be controlled from this panel include pen movements, viewing of the current plot, production of a "demo" plot, rotation of plot axes, number of copies to generate, and various configuration related parameters. Paper can be fed one sheet at a time or automatically through the "Auto Feed" button. Operating mode can also be set for accessing the plotter's terminal port rather than the RS-232-C port for direct access to the plotter.

The HP 7550A has been set up as a queued device on the VAX 11/750. This means that plots will be run on a first-in, first-out basis. Spooling of plots to this queue is done, transparent to the user, when HP is chosen as the output device by any SEAPAK program. Previously generated plot files can be sent to the plot queue with the system command "HPLOT" followed by the HP-GL file name.

Two of the SEAPAK environmental data applications programs, TIMENV and GEMPLOT, support the generation of "keystroke journal" files which ultimately can produce plotted output. These files, which can be started up at any time during execution of one of these programs, contain a logging of all commands typed in through the Transportable Applications Executive (TAE) interface, described in the software chapter. Another SEAPAK program, called TOHP, allows the user to "replay" the inputs of the TIMENV or GEMPLOT run, sending the output to the HP 7550A. Typically, users will preview the output on a Tektronix-compatible terminal supported by GEMPAK, saving the keystrokes in a file as they proceed, then run TOHP to get a hardcopy of what they saw. When running TIMENV or GEMPLOT, the user may wish to save the journal files rather than the HP-GL plot files, since the latter are much larger in size. Journaling is not supported in the other SEAPAK programs using the

plotter, since these run on the M75 and require user intervention to press program function buttons on the trackball unit's keypad.

GEMPAK/GEMPLT Supported Devices: The GEMPAK/GEMPLT meteorological graphics package used in conjunction with SEAPAK supports many terminal and hardcopy devices. The primary ones used with SEAPAK imaging and environmental data programs are the M75, Digital VT240 graphics terminal, Hewlett Packard 7550A pen plotter, Tektronix 4105A-compatible graphics terminal, Apple Macintosh, and various Tektronix 4105A emulators on personal computers. In addition, GEMPAK/GEMPLT supports these other devices: Digital VT100 retrographics terminal, Versatec plotter, Tektronix 4010/4014 (monochrome) and emulators, Bausch and Lomb pen plotter, Digital LA100 printer plotter, Digital LN03 laser printer, and QMS laser printer. A brief description of the graphics devices follows.

1. IIS Model 75 - the image related functions of this device are described earlier in this section. Before running any applications, the IIS must be "allocated" using SEAPAK's ALLOC program. For the generation of plots, GEMPAK's device driver uses the graphics channels to draw lines, arrows, text, contours, and other symbols as needed. All or specific bit planes within this channel can be cleared using SEAPAK's GRPINTL program or all 8 bit planes can be cleared with GEMPAK's GPCLEAR. Output is generally faster than for the other devices--the entire output is typically generated in one or two "chunks" on the M75 screen. To save the graphical output to disk or restore it from disk, either the SEAPAK program BPSAV (for both save and restore), or the GEMPAK programs GPSAVE (for saving) and GPREST (for restoring) can be used.

2. Digital VT240 graphics terminal - GEMPAK contains a driver to create color output on this device using the Regis graphics language. This terminal has the advantage of allowing the user to run the TAE interface and generate graphics on a single terminal. However, the graphics and alphanumeric interface are written to the same "plane." This means that all graphics which are part of a unit (i.e. map and accompanying contours) must be drawn at the same time. Switching from graphics to text mode will result in the graphics scrolling toward the top of the screen each time a carriage return is entered.

3. Hewlett Packard 7550A pen plotter - this is fully described earlier in this section.

4. Tektronix 4105A-compatible graphics terminal - like the VT240, this is a combined graphics/text terminal. However, a 4105A-compatible terminal, such as Intecolor's Color Trend 4100, Model 140, used in the Laboratory for Hydrospheric Processes can store the text and graphics as separate "windows" on the screen. This means that the interface can overlay the graphics drawn and will not destroy or alter it in any way. Although GEMPAK software will draw only eight colors to this terminal, the user can interactively

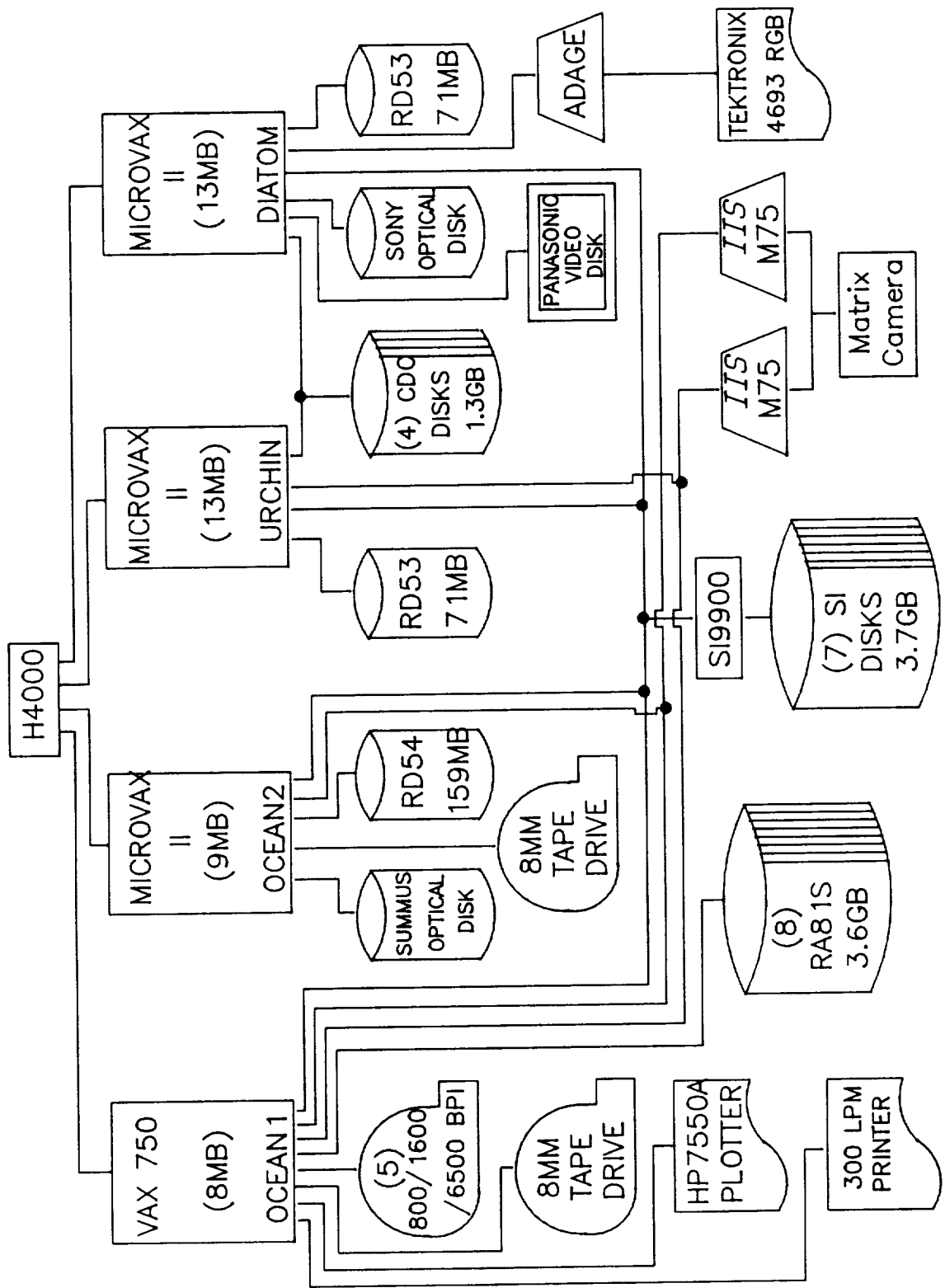
alter the colors displayed through the terminal's own hardware. Colors can be chosen from a pre-defined set or specified by their hue/lightness/saturation (HLS) components or RGB components. Up to 16 colors, taken from a palette of 64, can be displayed for the text/dialog and graphics areas. An optional mouse can be purchased as a pointing device.

The Model 140 is a 19-inch monitor with 1024x720 resolution; there is also a Model 100 which is a 14-inch monitor with 480x360 resolution similar to the original Tektronix 4105A. The Color Trends support Tektronix zoom, pan and roam, as well as Intecolor enhancements which include blink (to enhance certain colors) and flow (to simulate motion). Supported hardcopy devices include Tektronix 4695 or 4696 color copiers, monochrome copiers such as the Tektronix 4644, HP ThinkJet or Epson-type dot matrix printers, and parallel text printers having a Centronics style interface. Two alphanumeric screens and two graphics screens can be maintained. In lieu of two graphics screens, one "superscreen" can be drawn, having resolution of 700x525 (Model 100) or 1024x730 (Model 140). Roaming can be used to view any 480x360 portion of the superscreen. DEC VT100 and VT52 emulation is also included so that the terminal can be used for text editing.

5. Macintosh - GEMPAK uses a monochrome Tektronix terminal (4010/4014) emulation to create graphics on the Apple Macintosh or Macintosh II. A commercial package such as Versaterm-Pro must be installed on the Macintosh to perform this emulation. When a graphics program is run under TAE, GEMPAK will put the Macintosh in graphics mode automatically and return it to text mode when the graphics is complete. On the Macintosh, unlike the VT240, there is enough memory for the graphics to be accessible even after it is drawn. Since text and graphics do not overlay one another (e.g. appear simultaneously) as on the Color Trend, the user must manually change between text and graphics modes. This can be done easily through Versaterm Pro's interface.

6. Tektronix 4105A emulators for personal computers - these cover a broad spectrum of commercial products offering differing degrees of true 4105A emulation. Examples of emulation packages available at the OCF are Grafpoint's TGRAF-715 and Scientific Endeavors' VTEK. These perform more similarly to the original Tektronix 4105A than to the Color Trend described above. These emulators are capable of providing graphics generated by GEMPAK within SEAPAK programs at a fraction of the cost of a dedicated graphics terminal.

OCEANS COMPUTER FACILITY VAX CLUSTER



SYSTEM ENVIRONMENT: SOFTWARE

SEAPAK was written to run under the VAX/VMS operating system. In order to invoke SEAPAK the user must first execute the VMS command

```
@xxxx:[SEAPAK]LOGIN
```

(1)

where "xxxx" is the name of the disk drive on which the main SEAPAK directory resides or a VMS logical defined as that drive. This command executes the login command file of the SEAPAK account which in turn defines a number of VMS logicals and symbols (see the section on VMS below) required for the proper functioning of SEAPAK. One of these is the symbol "SEAPAK" which the user may then enter as a VMS command in order to invoke SEAPAK. For convenience, Command 1 should be included as part of a user's account login command file. This is a file consisting of DCL commands which are executed automatically whenever that account is logged onto. In this way, "SEAPAK" will be available automatically for use as a command after logging in.

SEAPAK is a collection of programs designed principally for the analysis of CZCS images. All of these programs use NASA's TAE (Transportable Applications Executive) for their user interfaces. Therefore, SEAPAK requires that TAE be installed on whatever system it is to be used. A brief discussion of relevant TAE aspects is given in a separate section below. The imaging system used by SEAPAK is the IIS Model 75 which is also discussed separately.

For the Laboratory of Hydrospheric Processes' local area VAX cluster, the main SEAPAK drive ("xxxx" in Command 1) is SIA0. As implemented on this cluster, SEAPAK may be invoked from any of the four nodes: OCEAN1, URCHIN, DIATOM, and OCEAN2. With certain exceptions, most programs may also be run from any node. Two Model 75 systems, ATLANTIC and PACIFIC, are available--ATLANTIC from OCEAN1 and URCHIN and PACIFIC from OCEAN1 and OCEAN2. Programs requiring the use of a Model 75 are, therefore, restricted to these nodes. An Adage imaging system for use with the University of Miami's image analysis system, DSP, is available from DIATOM. SEAPAK programs (e.g., DSPIMG) related to the conversion of DSP image files make use of DSP but may be run from any node. Ingest programs (e.g., TP2IMG) require 9-track tape drives and, therefore, are restricted to OCEAN1, the only node from which the tape drives are accessible. In addition, the Sony optical disk drives can only be accessed from DIATOM and the 8mm tape drive operates only from OCEAN1.

VIRTUAL MEMORY SYSTEM (VMS)

VMS is an operating system for VAX computers which uses DCL (DEC Command Language). Extensive on-line help on many of the

topics discussed in this section may be obtained by simply entering the DCL command HELP. DCL commands may be abbreviated to the fewest letters which will not cause ambiguity with other commands. SEAPAK-specific definitions may be obtained by pressing the HELP key.

VMS Symbols: In VMS, "symbol" refers to a character string which has been defined to represent another string--usually a DCL command or a portion of one. Symbols may be defined using the "==" characters. For example,

```
ST == SHOW TIME
```

defines "ST" to be the DCL command SHOW TIME which shows the current system date and time. Symbols defined in this manner remain valid only during the session in which they are defined unless they are included in the account's login file.

SEAPAK users may enter the symbol "SPSYM" to display symbols defined for them by the SEAPAK login file (Table 1). These symbols may be redefined to represent other strings after the SEAPAK login file is executed.

VMS File Names: The names of files in VMS consist of various portions which specify the location of the file as well as its name. The string

```
OCEAN1::BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
```

Table 1. VMS symbols defined by the SEAPAK login command file for SEAPAK users on NASA/GSFC's OCF VAX cluster. Symbols containing an asterisk may be abbreviated down to the letters preceding the asterisk. (The asterisk is not part of the symbol.)

<u>Symbol</u>	<u>Definition</u>
SEAPAK	Invokes SEAPAK
CPU	Displays system's CPU usage
USE*RS	Lists users logged onto system
SI	Lists information for devices with "SI" in name
DU	Lists information for devices with "DU" in name
PAC*IFIC	Displays information for PACIFIC (IIS Model 75)
ATL*ANTIC	Displays information for ATLANTIC (IIS Model 75)
IIAO	Displays information for PACIFIC (IIS Model 75)
IIBO	Displays information for ATLANTIC (IIS Model 75)
BBQ	Displays jobs on SYS\$BATCH queue
LPQ	Displays jobs for line printer queue
HPQ	Displays jobs for HP plotter queue
W132	Sets terminal width to 132 characters
W80	Sets terminal width to 80 characters
SP	"SET PROTECTION="

Table 1. VMS symbols defined for SEAPAK users at OCF. (Cont'd)

<u>Symbol</u>	<u>Definition</u>
PU	Purges directory's files which are not most recent versions
LOGIN	Runs login command file in user's account
GEMPAK	Runs GP\$DSK00:[GEMPAK]GEMPAK.COM
HOME	Sets default to home directory from any directory
SPDEF	Displays logicals defined by SEAPAK login command file
SPLOG	Displays SEAPAK login command file
SPSYM	Displays symbols defined by SEAPAK login command file
SPTERM	Displays terminal characteristics defined by the SEAPAK command file
ASC	Lists *.ASC files in default directory with date, size
BLO	Lists *.BLO files in default directory with date, size
CTL	Lists *.CTL files in default directory with date, size
DAT	Lists *.DAT files in default directory with date, size
IMG	Lists *.IMG files in default directory with date, size
L2P	Lists *.L2P files in default directory with date, size
LIS	Lists *.LIS files in default directory with date, size
LOG	Lists *.LOG files in default directory with date, size
PAR	Lists *.PAR files in default directory with date, size
TXT	Lists *.TXT files in default directory with date, size

is an example of a valid file name. In this case, "OCEAN1" is the name of the system or node, "BIO4" is the name of the device (such as disk drive), and "MYACNT.SUBDIR" specifies the path to and the name of the directory, SUBDIR. "GOOD_DATA" is usually referred to by the compound word "filename" to indicate this specific (and main) portion of the name. Finally, "RECENT" is called the file name extension or type.

If the node, device, or directory are not specified in a file name entered as part of a DCL command, VMS assumes the current node, device, or directory by default. The DCL command SHOW DEFAULT will display the current device and directory. SEAPAK users may also press the PF1 key which will change the prompt string (up to 32 characters) to be the current node, device, and directory; pressing PF1 again returns to the default prompt.

VMS Logical Names: In VMS, a character string may be defined to represent a file name or a portion of a file name and used subsequently when specifying that file. Such strings are called logical names, or logicals, and may be defined using the DCL DEFINE command. For example, the following commands may be entered:

```
DEFINE LOG1 BIO4
DEFINE LOG2 BIO4:[MYACNT.]
DEFINE LOG3 LOG2:[SUBDIR]
DEFINE LOG4 LOG3:GOOD_DATA.RECENT
DEFINE LOG5 BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
```

These commands would render equivalent the following file name specifications:

```
BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
LOG1:[MYACNT.SUBDIR]GOOD_DATA.RECENT
LOG2:[SUBDIR]GOOD_DATA.RECENT
LOG3:GOOD_DATA.RECENT
LOG4
LOG5
```

Logical names can greatly reduce the amount of typing required to specify files. For example, "LOG3" above can be used as a prefix when specifying any of the files in the directory it represents. Moreover, if a logical is used as part of a name inside a file, it may be redefined to represent another directory or file name without having to modify (edit) the file.

Logicals remain valid only during the session in which they are defined unless they are included in the account's login file. SEAPAK users may enter the symbol "SPDEF" to display logicals defined for them by the SEAPAK login file. These logicals may be redefined to represent other name parts after the SEAPAK login file is executed.

File Names as SEAPAK Parameters: Many SEAPAK programs require file names as input parameters. With some exceptions, SEAPAK programs will generally supply certain parts of a file name specification by default according to the convention described here. For more specific information, the reader is referred to the descriptions or help texts of the file name parameters for each program.

If a device is not specified in a name, the logical "SCRATCH" will be used. If the device and the directory are not specified, the root (topmost or main) directory will be used along with "SCRATCH". If an extension (including the period) is not specified, an extension (as mentioned in that parameter's description) will be supplied. The following are examples of the entries for file name parameters and the actual names used assuming that the current default directory is "[MYACNT.SUBDIR]" and that the default extension is "IMG":

N_ATL	==>	SCRATCH:[MYACNT]N_ATL.IMG
[MYACNT.OCEANS]N_ATL	==>	SCRATCH:[MYACNT.OCEANS]N_ATL.IMG
BIO4:N_ATL	==>	BIO4:[MYACNT.SUBDIR]N_ATL.IMG
BIO4:N_ATL.	==>	BIO4:[MYACNT.SUBDIR]N_ATL.
BIO3:[MYACNT.OLD]N_ATL.DAT	==>	BIO3:[MYACNT.OLD]N_ATL.DAT

The reasons for this logic are as follows. Users may have space reserved on a device other than the home disk for storing certain files, especially large ones such as image or data files. This device can be assigned the logical name "SCRATCH". (This name does not imply anything about the permanency of the files.) For the same account, such an alternate device would not likely have a directory structure like that of the home device or, for that

4 SYSTEM ENVIRONMENT: SOFTWARE

matter, may not have any subdirectories at all. Thus, not specifying the device and directory indicates to the program that the root directory on "SCRATCH" is to be assumed (first example). Similarly, if the directory but not the device is specified (second example), that directory is used but "SCRATCH" is assumed. However, if the device is specified but not the directory (third and fourth examples), the current default directory (a root or subdirectory) is assumed.

Users who do not have space reserved on an alternate device for this purpose may wish to redefine "SCRATCH" to be the home device after the execution of the SEAPAK login file. This would remove the need to specify the home device in each file name entry.

Conventional File Name Extensions: File name extensions are normally used to indicate the type of information stored in files while filenames are used to differentiate between files with the same extension in a given directory. Within VMS, certain extensions are reserved as defaults for files with certain types of information. This is done only for uniformity and organizational purposes and any extension may be used for any file if the extension is specified (i.e., not allowed to default). (Directory files, however, must have the extension "DIR" so as not to obtain inconsistent results with some DCL commands.)

SEAPAK and TAE also reserve certain extensions as defaults according to the type of information contained in files (Table 2). Whether reserved by VMS, SEAPAK, or TAE, these extensions prove helpful when users follow the convention of their usage.

TRANSPORTABLE APPLICATIONS EXECUTIVE (TAE)

When a user enters "SEAPAK" to invoke SEAPAK, it is the application executive TAE (Century Computing, Inc., 1985; Perkins et al., 1988) and its interface which is actually invoked. The interface has only been slightly modified to customize it for SEAPAK users. For example, the command prompt "SEAPAK>" is seen instead of the generic default prompt, "TAE>". TAE is a powerful system providing on-line help, different execution modes, automation of commands, and command syntax flexibility. Only a rudimentary description of these capabilities is given in this section; more extensive information may be found in usage manuals available from NASA/GSFC's TAE Support Office (Code 521).

Command and Menu Modes: There are two interactive methods of invoking programs in TAE, by commands or from option menus. The default method for SEAPAK is by commands--the command prompt "SEAPAK>" is displayed after the initial header page when SEAPAK is invoked. A user can switch to menu mode by entering the TCL (TAE Command Language) command "MENU" at a command prompt and switch back by entering "COMMAND" while in menu mode. (TAE distinguishes between various types of commands: TCL, menu, tutor, and program names. All of these, except program names, may be abbreviated down

Table 2. SEAPAK conventions for file name extensions.

<u>Extension</u>	<u>Code</u>	<u>File content or type</u>
ANC	ASCII	Control point file associated with full-scan CZCS image
ASC	ASCII	All or part of a SEAPAK image
BLO	Binary	IIS Model 75 graphics
CLR	ASCII	Results from SEAPAK's clear water algorithm programs
COM	ASCII	VMS DCL command file
CTL	ASCII	Control point file associated with unmapped SEAPAK image
DAT	ASC/Bin	General data file
DIR	Binary	VMS directory file
EXE	Binary	VMS executable file
FOR	ASCII	FORTTRAN source code
FUL	Binary	Full-scan SEAPAK image
HLP	ASCII	Help text for SEAPAK program
IMG	Binary	Standard SEAPAK image
L2P	ASCII	Log file from SEAPAK's level 2 programs
LST	ASCII	Tabulated data
LOG	ASCII	Output from a batch job
LUT	Binary	IIS Model 75 look-up-table definition
OBJ	Binary	Compiled program file
PAR	Binary	TAE parameter file
PDF	ASCII	TAE parameter definition files
TSL	ASCII	TAE session log

to the fewest letters needed to avoid ambiguity. None of the commands are case specific. TCL commands and program names may be entered any time at a command prompt. Commands available in menu and tutor modes are listed at the bottom of their respective terminal displays. TCL commands are those of the TAE Command Language.)

In command mode, the user may enter the TCL command "TUTOR" followed by the program name in order to obtain the tutor (or parameter) menu for that program. (TCL commands may themselves also be used with TUTOR.) This menu will display all the parameters required for running the program along with any default values. As values are entered for each parameter, the menu is updated to display the new values. When all entries are made, the program may be started with the tutor command "RUN".

An alternate way of invoking a program in command mode is to enter that program name and required parameters as a command line. For example,

CURMOD CHANNEL=5 COLOR=(RED, GREEN) (2)

will run the program CURMOD with the values specified for its parameters. The default values will be used for parameters not

listed (such as STARTPIX and ENDPIX for CURMOD in Command (2). Parameter names may be abbreviated if there is no ambiguity. The names and the equal signs may be omitted altogether if the values listed are in the order that the parameters appear on that program's tutor menu. A plus sign may be used as the last character in a line to indicate that the command continues on the following line.

In menu mode, each menu presents the user with a set of options from which to select. The options represent either programs, enclosed by parentheses, or other menus, enclosed by square brackets. If a menu option is selected, that submenu will then be displayed. If a program option is selected, the tutor menu for that program will be displayed and the user may proceed as described above. After a program is run, the same option menu will reappear.

SEAPAK programs are organized into menus with a tree structure.) (See listing of the menu tree structure in Appendix.) The user may navigate forward along the tree by selecting menu options, or backward by entering "BACK", until the desired program is given as an option on the displayed menu. Each menu represents a logical grouping of programs and submenus. (A complete tree structure of the SEAPAK menus and programs is presented elsewhere in this guide.) Inexperienced users will find the menu mode easier to use for locating and invoking the programs needed to accomplish a given task. For more experienced users, command mode provides a more rapid way to invoke any program directly.

Subcommands and Dynamic Parameters: Some SEAPAK programs (e.g., DERIV) have more than one major branches in their processing logic which are distinguished by "subcommands." (Many TCL commands also have subcommands associated with them.) The subcommand name, preceded by a dash, must be appended to the program name if entered as a command line. Tutoring on such programs will display a subcommand menu. The tutor menu for a subcommand version of the program will be displayed after a subcommand is selected. Alternately, the tutor menu for a subcommand version of the program may be obtained directly by appending the subcommand (with dash) to the program name in the TUTOR command. Subcommand names may be abbreviated.

In many cases, SEAPAK programs require values to be input for "dynamic" parameters. These are parameters whose values are required during execution of a program. Which parameters to request, if any, and their default values, if any, may need to be determined by the program based on the values of the initial input parameters. A program will then generate a prompt or tutor menu requesting the values for these parameters. (If a prompt is issued, the tutor menu may be obtained by entering "TUTOR".) After entering these values, the user may enter "RUN" to continue with the program. The parameter value list may also be entered on the same line after this RUN command in the same way that a program is invoked from command mode without tutoring. Requests for dynamic parameters may occur more than once for a given program.

Parameter Files: TAE provides a convenient way to save the values entered for a program's set of parameters. This may be done using the SAVE command while in tutor mode or at a dynamic parameter prompt to create a disk file in the default directory containing the parameter names and their values. These values may be reloaded subsequently for the same parameters with the RESTORE command or qualifier. If the parameters in a parameter file do not match those for which the values are to be restored, an error message will be issued when RESTORE is used.

The form of the SAVE command is "SAVE fname", where "fname" is the name of the parameter file. If the extension (type) is not specified in "fname", ".PAR" is assumed; if the directory (path) is not specified, the current default directory is assumed. If "fname" is omitted, the program name is used by default as the file name with the type ".PAR". Dynamic parameters are also associated with a program name, usually being the main program name with the characters "DYN" appended. This name would thus be used as the default parameter file name in a SAVE command for dynamic parameters. (All tutor menus indicate the name of the associated program at the top of the display. Dynamic parameter prompts also indicate the associated program name in the prompt string after "SEAPAK-".)

In tutor mode or at a dynamic parameter prompt, the RESTORE command also has the form "RESTORE fname" where "fname" is as described above. When this command is entered, the display will indicate the restored values.

RESTORE may also be used with a different syntax as part of a command line when invoking a program as in the following example:

```
CURMOD |RESTORE="PARSET1"| CHANNEL=3 (3)
```

In this example, "PARSET1" indicates that PARSET1.PAR is the parameter file name and that it is located in the default directory since the path is not specified. In this case, RESTORE is actually a TAE-specified parameter called a command qualifier. These qualifiers can only be listed between vertical bars on a command line. Any parameter values listed after the RESTORE qualifier on the command line (such as "CHANNEL" in Command 3 will override those in the parameter file. If an empty string (indicated by two double quotes "") is given for the RESTORE qualifier, the program name is assumed for the parameter file name.

Any time a program is invoked from a tutor menu or continued from a dynamic prompt or tutor menu, the parameter names and their values are automatically saved in the default directory in a parameter file called LAST.PAR. Thus, entering "RESTORE LAST" causes the values to be restored as they existed when "RUN" was previously entered. Obviously, this feature is very useful when running a program more than once consecutively.

Using DCL from within TAE: One of the TCL commands is "DCL" which allows the user to enter DCL commands without exiting SEAPAK (i.e., TAE). The command has the form "DCL comnd" where "comnd" is the actual DCL command including any associated qualifiers and

parameters. If "comnd" is omitted, the prompt "_\$" will be displayed, placing the user in DCL mode where DCL commands may be entered directly. To exit DCL mode and return to SEAPAK, the user can enter "EXIT" or "TAE".

"DIRECTORY" is a DCL command which, for convenience, may be entered directly as a TCL command without being preceded by "DCL". Qualifiers allowed by DCL for DIRECTORY (e.g., "/SINCE") also may be used in the same way with the TCL version of that command.

Batch Execution: A program may be submitted to the system's batch queue by setting the qualifier RUNTYPE to "BATCH". Running a program in batch allows the user to proceed with other tasks while the batch program is running or waiting to be executed. Therefore, it is very advantageous to use batch jobs for programs requiring extended time to run or for running a large number of programs. Once a program is submitted, it is no longer dependent on the current session which may terminate before the program ends or starts executing. Obviously, batch execution may not be used for programs which require interaction with the user such as by the use of a Model 75 or dynamic parameters. (Some programs, such as MAPIMG, which use dynamic parameters have been specially designed to enable batch execution. Such exceptions are noted in the descriptions of these programs.)

When the submitted program executes, a log file containing the program's output that would normally appear on the terminal along with other information will be created. The file will have the name of the program with the type ".LOG" and will be located in the main directory of the user's account. Log files include the user's login file and any command files which it invokes, such as the SEAPAK login and associated files.

The following example shows how a program may be submitted to the batch queue in TAE command mode:

```
ADDF |RES="",RUN="BATCH"| FACTOR=3
```

(4)

This command submits the program ADDF to run in batch using the parameter file ADDF.PAR in the default directory but with the value of 3 for the parameter FACTOR. (The qualifiers "RESTORE" and "RUNTYPE" have been abbreviated.) In tutor mode, the command

```
RUN |RUN="BATCH"|
```

(5)

will submit the program being tutored using the parameter values currently on the tutor menu.

The SHOW-BATCH or BATCH-STATUS commands may be used to examine the status of a batch job. The ABORT-BATCH command may be used to abort a submitted batch job. The abort command require as input to a parameter, JOBID, the entry number assigned to the batch job. This number is displayed on the terminal immediately after the job is submitted and may be examined using the status commands. For example,

SHOW-BATCH
ABORT-BATCH JOBID=906

(6)
(7)

will abort job 906 which the user would have observed as being on the queue by the SHOW-BATCH command. These and other batch-related commands also require as input the name of the batch queue in question since host systems may have more than one such queue. In most of these commands, the default value for the QUEUE parameter is the VMS logical "SYS\$BATCH"; for BATCH-STATUS, the default value for the QUEUE parameter is "ALL". The default QUEUE value is used in Commands 6 and 7.

It is very important to realize that the system environment under which a batch job will execute is the same as that which exists immediately after logging in to the system. That is, VMS logicals and symbols defined during the session in which the batch job is submitted will not be valid unless they are included in the account's login command file. This fact often leads to failed attempts by novice users of the batch capability.

One of the major advantages of running batch jobs is to delay their execution so that they are run at a time (e.g., overnight) when they will not adversely impact the system's users by consuming excessive amounts of CPU time. The DCL command SUBMIT, used to run batch jobs, allows the user to specify the time of execution among many other options for that command.

As the following pair of commands indicate, TAE provides a way for the user to take full advantage of the power of the SUBMIT command.

ADDF |RES="",RUN=("BATCH","NORUN")| FACTOR=3 (8)
DCL SUBMIT/AFTER=22:00/NOPRINTER/KEEP ADDF.JOB (9)

Command 8 instructs TAE to create the same batch job as that of Command 4 but not to run it (i.e., not to submit it to the batch queue). Command 9 tells TAE to execute the DCL command SUBMIT for the batch job file "ADDF.JOB" created by Command 8. The DCL "/AFTER" qualifier to SUBMIT indicates that the job is to be queued for processing after 10 PM. The "/NOPRINTER" and "/NOKEEP" qualifiers indicate that the log file should not be automatically printed and should be deleted from the disk, respectively; "/PRINTER" and "/KEEP" may be used to indicate otherwise. ("/PRINTER" is the default for the DCL command SUBMIT; "/NOKEEP", which deletes the disk file, is the default when "/PRINTER" is used, otherwise "/KEEP" is the default. A log file should not be automatically printed as it may be quite long. For convenience, "SUBMIT" has been defined as a symbol for SEAPAK users to represent the DCL command SUBMIT/NOPRINTER/NOTIFY. The "NOPRINTER/KEEP" qualifiers in Command 9 are not required since the no-print option is, in effect, the default).

Asynchronous Execution: When a program is run asynchronously, it will begin executing immediately while permitting the user to proceed with the session. It will continue to execute concurrently

until it terminates or the session is terminated. Asynchronous jobs are initiated from SEAPAK in the same way as batch jobs except that the RUNTYPE qualifier is set to "ASYNC". A log file is also generated as for batch jobs.

Unlike batch jobs, asynchronous jobs can request dynamic parameters. When the program reaches a point in its processing where these parameters are required, it issues a message to the user. The program is then suspended until the user responds using the REPLY command in menu or command mode. However, asynchronous execution is not allowed for programs requiring a Model 75.

The SHOW-ASYNC command may be used to examine the status of asynchronous jobs while ABORT-ASYNC may be used to abort them. Other commands related to asynchronous jobs are also available.

On-Line Help Text: Extensive on-line help text is available to the user at any point requiring user input. In command or menu mode, entering "HELP" provides a summary description of TAE commands. For more specific information, "HELP cname" can be used where "cname" is a command or program name. In menu mode "cname" may also be the number of an option on the current menu.

In tutor mode (as well as dynamic prompt mode), "HELP pname" will provide a more detailed description of the parameter "pname". If "pname" is an asterisk, a description of the tutored program will be displayed. If "pname" is omitted, general information on the tutor mode will be provided.

Other TAE Features: The TCL DEFCMD command may be used to define a string as a temporary TAE command which may be used subsequently in a given session. For example,

```
DEFCMD RUN*CURM STRING="CURMOD |RESTORE=""PARSET1""|CHANNEL=3" (10)
```

defines "RUNCURM" to be Command 3. The asterisk indicates that the newly defined command name may be abbreviated down to "RUN" and still represent the same command. Double quotation marks occurring in the definition string must be repeated to indicate that they are part of the string.

For commands which will be repeated the same way or with slight modifications, the use of command files can prove very useful. In TAE, such files are called procedures and become essentially additional programs. Procedures consist of TCL commands and program invocation command lines. Among other capabilities, TCL allows unconditional and conditional branching, looping, and communication with programs invoked from the given procedure. Therefore, a user may create procedures which can vary greatly in complexity depending on the task to be performed as well as the user's own ability with TCL.

A log file of program invocations during a SEAPAK session may be created using the TCL command ENABLE-LOG. When this command is issued, a file called SESSION.TSL is created in the user's default directory. The command DISABLE-LOG is used to disable session logging while the command SESSLOG may be used to examine the log

file. (SESSLOG automatically enables logging if it had been disabled. When logging is enabled more than once the same log file is used.) The log file keeps a record of all program invocations, their parameters and parameter values, program termination output values, and other information.

To abort a program in progress, the user should enter "<control>C" followed by "ABORT" at the next prompt. The user should avoid entering "<control>Y" which may terminate the SEAPAK session as well as any executing program.

To end a SEAPAK session without logging off the host system, the user may enter the TCL command "EXIT" at the command prompt. This command is not available in menu mode. In tutor mode, "EXIT" will return the user to the command prompt or the previous option menu without invoking the program. At a dynamic prompt or tutor menu, "EXIT" will result in action controlled by the internal logic of the program, which usually is termination of the program. To terminate a SEAPAK session as well as log off the system, "LOGOFF" may be entered in command or menu mode.

IIS SYSTEM 575

The IIS Model 75 comes with System 575 software which contains its own user interface, data base management system, and a library of intrinsic functions (International Imaging Systems, Inc., 1984). When SEAPAK was first developed, System 575 was evaluated for its user interface and data base management capabilities and the decision was made to use only the intrinsics, including hardware-specific and hardware-independent functions, for SEAPAK development. Portions of the Model 75 software used by SEAPAK are described briefly here.

Device Handler: The Model 75 device handler package is the most basic software package. It provides the interface to the Model 75 display hardware. The device handler used by SEAPAK is specific to the VAX/VMS operating system.

Interface and Utility Routines: The interface and utility routines package consists of a collection of about 80 FORTRAN-coded subroutines. The 30 interface routines are used to control the various Model 75 hardware components (refresh memory, look-up tables, cursor, IFM, OFM, feedback unit, etc.). The utility routines provide higher level of interface to the Model 75.

Primitives Package: The primitives package consists of approximately 60 FORTRAN-coded subroutines that provide a high level of software interface to the Model 75's hardware image processing capabilities. These subroutines call the interface and utility subroutines to accomplish the image processing function utilizing the Model 75 hardware features.

GENERAL METEOROLOGICAL PACKAGE (GEMPAK/GEMPLT)

SEAPAK uses GEMPAK/GEMPLT software (desJardins et al., 1988 and 1990; desJardins and Petersen, 1989) to facilitate the computation and display of gridded oceanographic and meteorological parameters taken from a variety of data sources. Some examples of these data include global data sets of bathymetry from NORDA, winds from FGGE, FNOC or NMC, and SST's from NOAA's CAC. These data, in the form of contoured fields or wind vectors/streamlines, serve as an ancillary overlay on the CZCS or AVHRR imagery supported within SEAPAK.

GEMPAK is a large software package for meteorological data analysis, developed and maintained in the Severe Storms Branch of the Laboratory for Atmospheres, NASA/GSFC. The programs are run from either the menu or command modes of the TAE interface. There is also a FORTRAN-callable subroutine library available with GEMPAK that allows access to the component parts of the applications programs. In SEAPAK, this library is used to perform scalar and vector gridded diagnostic computations (e.g., surface stress, divergence, Ekman transport) from observed zonal and meridional wind components. Major subdivisions of the GEMPAK menu tree are devoted to analysis of surface data, upper air sounding data, gridded data, and the performing of objective analyses to place irregularly spaced observations in a gridded array. The GEMPAK package of analysis programs may be accessed directly from SEAPAK's root menu.

GEMPAK can handle both real-time (from a FAA 604 data line) or historic, conventional meteorological data. Surface programs allow the user to create binary surface datasets, insert data into this file from another binary file or an ASCII text file, and list or map data from the binary file onto any of the supported graphics devices. There is a great deal of flexibility in choosing the data and graphics regions, time periods, and characteristics of the output including colors, line types and widths, map backgrounds, contour intervals, etc. Upper air programs include drawing of vertical thermodynamic and wind profiles for specific stations, creation of a horizontal contour map by combining data for many soundings at a given level, drawing of a horizontal cross section composed of several soundings, various data listing programs, and sounding dataset manipulation programs. Gridded data set programs support horizontal maps of the data, contouring, wind barbs, arrows or streamlines, creation of vertical profiles from co-located grids, creation of diagnostic grids, and various listing and grid file manipulation programs. The objective analysis package performs a Barnes analysis of either sounding or surface data irregularly spaced, creating a grid with the latitude/longitude spacing specified by the user.

GEMPLT handles the display of output from the GEMPAK applications programs. Like GEMPAK, GEMPLT can be accessed from a TAE menu interface or a FORTRAN subroutine library. The menu portion consists of control programs, attribute programs, and plotting programs. The control programs provide for the initial setup of

GEMPLT with a specified graphics device, setting of map projections, clearing the device, and handling of plot files for hard copy devices. Attribute programs allow control over the view region for graphics on the specified device, and characteristics of the colors, markers, lines, wind indicators and maps which will comprise the output. Plotting programs can perform the drawing of grids, titles, borders, and maps, in addition to the saving and restoring of graphics to/from disk for devices having a readback capability.

SEAPAK's environmental data module, and a group of image processing programs which use the HP 7550A plotter, make extensive use of the library routines of GEMPLT. For example, using GEMPLT's map mode, program GEMPLOT can draw contours of raw or diagnostic data, grids, or wind vectors overlaying coastlines or political map boundaries in a variety of projections. The user can control where the plot is drawn on the chosen graphics device, and any of the characteristics controllable through the attribute program menu. Similar control is given within SEAPAK program TIMENV, which uses GEMPLT's graph mode to create time series X/Y plots. By using the GEMPLT subroutines in a FORTRAN program rather than using the menu interface, customized applications can be built. These applications can take advantage of hardware features and data formats not used by the menu interface. For instance, GEMPLOT and TIMENV can utilize the trackball and button interface available on the IIS Model 75 for user interaction with the software. They also support data sets in the NSSDC Common Data Format (CDF; Treinish and Gough, 1987), which provides access to a multitude of space science, oceanography and meteorology data sets stored at NASA/GSFC.

LAND ANALYSIS SYSTEM (LAS)

Another major software component accessible from SEAPAK's root menu is NASA's Land Analysis System (LAS; Science Applications Research, 1987). This is a package for manipulating and analyzing multi-spectral image data. Functions include the ingest of various sensor data types, geometric and radiometric corrections, training site selection, image registration, Fourier domain filtering, supervised and unsupervised classification, and image enhancement. As with SEAPAK and GEMPAK/GEMPLT, LAS runs under the TAE interface, allowing access to the programs through menu and command modes, with an extensive on-line help facility. An accompanying Catalog Manager package provides users with the ability to assign names for data files, and to organize the cataloged set of names in a structure suitable for the user's application.

OPTICAL DRIVE AND JUKE MANAGER

Overview: This chapter describes the methods for reading and writing optical disks using the University of Miami JUKE_MANAGER software on a Sony model WDD-3000 laser drive. Although testing in the Laboratory for Hydrospheric Processes was done on the single-drive Sony, the processing scenarios are similar when using the "jukebox" installed at either the University of Miami or NASA/GSFC Coastal Zone Color Scanner (CZCS) global processing sites. The [OPTICAL...] directories on your VAX or MicroVAX contain the JUKE_MANAGER executables and related files.

I. DATABASE CONSIDERATIONS

The JUKE_MANAGER software communicates with an RDB database installed on the DEC VAX or MicroVAX containing the Sony WORM drive(s). The database, which at NASA/GSFC is the same one used for performing quality control (QC) on CZCS data, contains information related to the project name of optical disks in the archive, as well as the names of files present on these disks, volume label, version of the JUKE_MANAGER software used, disk status (open, closed, blank, currently being written), date initialized, registration date, number of free blocks, names of accounts writing to the disk, comments, etc. In order for the JUKE_MANAGER to allow read or write access to a disk, it must recognize the project name already on a previously-written disk or one to be assigned by the user for a new disk. A new project name can be written to relation LASER_DISK at the time of database creation or at a later point, by the database manager for your site. This chapter assumes that valid project names have been installed in your database, and you are ready to read/write a disk.

II. VMS CONSIDERATIONS

1. Privileges - There are no special system privileges needed for reading optical disks on the Sony when outside the JUKE_MANAGER. However, in order to use the JUKE_MANAGER for both reading and writing disks, the following system privileges are necessary: PHYS_IO, LOG_IO, SYSPRV and VOLPRO. Since these give the user a high degree of control over the system, it is suggested that great care be taken in creating an account for accessing the Sony. Preferably, a single experienced user should be charged with accessing the Sony drive for writing disks. If this is not possible, a "captive" account could be set up which can only access the JUKE_MANAGER. For example, at the NASA/GSFC Laboratory for Hydrospheric Processes, an account named "SONY" has been set up on node DIATOM for this purpose.

2. Logical names - The following logicals need to be set correctly before running the JUKE_MANAGER. These are located in the file "logicals.com" in the [OPTICAL] directory:

a. LASER_DATABASE - Defines the location of the RDB database mentioned above (i.e. SATDAT_DATABASE:GODDARD). This normally will not change once it is set.

b. LASER_SOFTWARE - Defines the version of the JUKE_MANAGER being run (i.e. JUKEPACK 1.0). It need only be changed with each revision to the software you receive.

c. LASER_SITE_NAME - Defines the local site where the JUKE_MANAGER is being run. It also serves as the prefix for the disk names assigned to new disks at initialization time (i.e. GSFC, NSSDC). The site name should ideally be six characters or less, since only 12 characters (including a six-digit sequence number) will be recognized in the full disk name. LASER_SITE_NAME is also set just once for a given site.

d. LASER_DISK_DRIVE - Defines the Sony device type (i.e. OSD1 for a single drive system). It will be set once for each site, unless the configuration is changed.

e. LASER_INIT_FILE - Defines the name of a file located in directory [OPTICAL.SOAR] having extension ".INP". This name will be used to define the category name for a disk to be initialized with the JUKE_MANAGER. This file is discussed below.

f. LASER_SPOOL_DIR - Defines the name of the optical disk directory to be written to when the Sony is accessed (i.e. [WINDS]).

Note: Items "e" and "f" will change with the optical disk and can be defined in a file separate from LOGICALS.COM, and executed after it, in order to override its default settings.

3. Files Required

a. .INP file - The logical name LASER_INIT_FILE points to a file which contains directory name and size information for a new disk to be initialized. This file should have an extension of ".INP" and be located in directory [OPTICAL.SOAR]. For example, a file named "WINDS.INP" will be used to define the directory structure on a newly initialized disk if "WINDS" is specified as the category name when option 5 ("Initialize disk in jukebox") is chosen from the JUKE_MANAGER menu and LASER_INIT_FILE is set to "WINDS". The file generally contains a single line of information in the following form:

[Sony directory name]/expected number of files to be written
to directory

2 OPTICAL DRIVE AND JUKE MANAGER

For example, a WINDS.INP file with the line:

```
[WINDS1]/1000
```

will result in the creation of a directory [WINDS1] on one side of the Sony disk. The specification of "1000" means that a maximum of 1000 files will be written to this side of the disk. If the maximum number is not exactly known ahead of time, an estimate can be obtained by dividing the capacity of a side in VAX blocks (3,276,000) by the size of the smallest file to be written. Unless most of the files are the same size, this estimate will be too large but this will not adversely impact the JUKE_MANAGER.

III. RUNNING THE JUKE_MANAGER

The JUKE_MANAGER software can be used for both reading and writing optical disks on the Sony WDD-3000 drive. Each disk (model WDM-3DL0) can be thought of as a large square phonograph record, with two sides for writing. Each side can hold approximately 3.25 million VAX blocks, or 1.6 gigabytes, of information. These data can be read or written out at speeds of up to 400,000 blocks per hour. Writing is done to one side of a disk at a time. The disk must first be registered and initialized before any writing in order to assign a disk name and create a directory structure. When writing is complete to one side, it is "closed"--that is, no more writing to this side is allowed, and the database is updated with information on the files contained therein--and the second side is then written. Reading can be done on either "open" or "closed" disks or sides of disks. Each side of the disk can be thought of as a separate entity, as far as the database is concerned. A separate entry is made in the database for each side in terms of a volume label, status code, and all other informational fields discussed above. However, it should be noted that both sides of the disk must be associated with the same project and category designations.

1. Starting Up the JUKE_MANAGER - If you are logging into a captive account, the Sony menu should appear automatically. If you are logging into a non-captive account (which must have certain system privileges), simply type "sony" from the DCL prompt to activate the Sony menu. The login file for this account should, at a minimum, contain the following lines:

Assuming the [OPTICAL] account is located on drive SIA1,

```
$ set default SIA1:[OPTICAL]
```

```
$ @set      This defines certain symbols, runs LOGICALS.COM to
             define the LASER__ logical names and runs
             [OPTICAL.SCSI]SETUP.COM to establish the controller
             and drive names and check necessary privileges.
```

A local set of logicals defining LASER_INIT_FILE and LASER_SPOOL_DIR could be placed after the "@set" line. An additional line needs to be included if the user intends to use the utility program "A", described in a separate section below, as follows:

```
$ setup 0 (drive number 0 or 1) (physical drive name)
      This defines controller number 0, drive 0 or 1 if
      you have two single drives and the corresponding
      physical drive--e.g., "setup 0 0 ldb0".
```

After typing "sony" a group of lines similar to the following appears:

```
you are SONY
site is GSFC-OCEANS
software is JUKEPACK 1.0
local disk drive is OSD1 (single drive)
laser disc init file is WINDS
laser disc spool dir is [WINDS1]
```

1. Insert disk into jukebox
2. Register disk in jukebox
3. Remove disk from jukebox
4. Check jukebox/database for consistency
5. Initialize disk in jukebox
6. Mount an open project disk in jukebox
9. Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

what would you like to do?

The first section above displays the account name accessing the Sony, as well as the settings of the various logical names. The main menu follows.

2. General description of Sony menu items

a. Choice 1 - "Insert disk into jukebox" - For a new disk, this is used to do a logical (software) insert of the disk into the drive. For closed disks, this also loads the disk's filenames into the database. It is suggested that choice 1 always be the first thing done when entering the menu, unless the user is certain that the disk is open or it is closed and contents have already been loaded by running the insert previously. When insert has already been run, the user can use choice 6 to logically mount the disk more quickly. In this case, more care must be taken to insure that the correct side is up. (The disk is written or read from the

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bottom. Therefore, if "B" side is loaded upward, the "A" side is actually being written.) The disk should be physically loaded in the drive before doing the software insert. For consistency, when using choice 1, the disk should always be loaded with the same side up (the "A" side is suggested). Simply place it in the Sony drive slot and apply a slight pressure. The disk will drop into the drive in a manner similar to the loading of a VCR tape. The JUKE_MANAGER will prompt you to flip and reinsert it at least once.

Choice 1 will typically lead to the following response from the JUKE_MANAGER when the disk is blank:

what would you like to do?

1

put disk on shelf 1

blank disk .. you should register disk on shelf 1

no file structure on default side

Please turn disk over and put back in drive, <cr> when ready

second side of this disk is unregistered

no file structure on second side

Note the request for turning the disk over at the midway point. The references to the need for registration and for a file structure will be addressed in choices 2 and 5 below.

If you get the message:

%Insert-E-BUSY, Disk already present in drive

this means that a software dismount was not done the last time the JUKE_MANAGER was exited. You can run choice 3 ("Remove disk from jukebox") at this point to perform the software dismount as well as a physical ejection of the disk, followed by choice 1 again. The only effect of choice 3 is the ejection of the disk--the menu will simply rewrite itself on the screen, without any messages for the user.

b. Choice 2 - "Register disk in jukebox" - Each new disk must be registered with the database so that it is assigned a unique name. This name is formed from the site name with a sequence number appended and is written to the disk and to the database when choice 2 is selected. The response from the host will look like the following:

what would you like to do?

2

%REGISTER-I-DO, Process disk on shelf 1

check default side

disk size is 3276000

Please insert other side of disc, <cr> when ready

look at other side
register other side
wrote registration to other side
Please insert other side of disc, <cr> when ready

register default side
wrote registration to default side
disk successfully registered

c. Choice 3 - "Remove disk from jukebox" - This performs both a physical and logical removal of the disk from the Sony drive. It should be used immediately before exiting the JUKE_MANAGER. If you select choice 3 when there is no disk physically mounted in the drive you will get the message:

%REMOVE-E-EMPTY, No disk in drive

d. Choice 4 - "Check jukebox/database for consistency" - This compares the contents of a disk to what is written in the database, and can be used to revise the database if necessary. It should be used following a power interruption or another event causing an abnormal termination to a write operation.

e. Choice 5 - "Initialize disk in jukebox" - This creates a volume label on the disk formed by the project name suffixed with a sequence number. Also, a directory structure is created on the disk, using the specifications of the .INP file. Lastly, a binary file containing a list of the files written to the disk is created on the host's disk in logical name SOAR. A sample exchange with the host follows:

what would you like to do?

5

enter project [ENV]

ENVDATA

enter category

COADS

shelf = 1

side = 1

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%LaserINIT-I-LABEL, Volume label is ENVDATA0004

%OINIT-I-CREMAGFIL, Creating file SOAR:ENVDATA0004.\$SOAR\$ with
2208 contiguous blocks

we initialized side 1

adjust info for side 2

force project on second side

force category on second side

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If the user accidentally tries to initialize a disk which has already been initialized, the following message will appear:

%LaserINIT-E-OPEN, Open disk ENVDATA0004 present for project ENVDATA

f. Choice 6 - "Mount an open project disk in jukebox" - This choice is used to logically mount and write to an open disk. An abbreviated menu will appear. The disk should have been previously installed physically into the Sony drive with the side to write to (if applicable) pointing DOWNWARD in the drive. This choice should be used if you wish to mount an open disk simply to check its contents (with a DIR command), and is recommended if you wish to write groups of files in "chunks" (i.e., not all at one time) because the disk is not dismounted after each group write as it is when using menu choice 12. A typical exchange follows:

what would you like to do?

6

enter project [ENVDATA]

enter category [COADS]

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

7. Copy a file to jukebox

8. Dismount disk in jukebox

13. Spawn a sub-process

14. Exit

Note: Entry of an incorrect project or category (i.e., one not recognized by the RDB database) or an attempt at mounting a closed disk with this option would have given the message:

%LaserMOUNT-F-NONE, No open disk for specified project

Trying to run choice 6 before the disk is physically loaded and logically inserted in the drive would give the message:

%LaserMOUNT-F-UNAVAIL, Disk is unavailable

The options in the abbreviated menu are herein described:

- Choice 7 - "Copy a file to jukebox" - Actually, this can allow multiple files to be written to LASER__SPOOL_DIR on the disk, depending on the user's file specification. The user specifies any

valid search pattern and the JUKE_MANAGER lists the applicable files and their sizes in Vax blocks. The user decides whether to copy all of the files or just certain ones and whether to rename or delete the files from disk (or do nothing) after copying to optical. This can continue indefinitely until a slash ("/") terminator is typed in. A sample session follows:

what would you like to do?

7

3274644 blocks available on optical disk

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

CDF\$DAT:46* GROUP3.*;

%LaserCOPY-E-INVPATTERN, Invalid search pattern

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

SIA0:[SEAPAK.CDF]46* GROUP3.C*;

1 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1 9

2 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

SIA1:[SEAPAK.CDF]46* GROUP6.C*;

3 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1 9

4 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

/

30 blocks in selected files

3273644 blocks available on optical disk

%LaserCOPY-I-OKALL, Accept all names for copy?

Y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to optical disc [delete, rename, nothing]

DELETE

%LaserCOPY-I-DELETE, Files will be deleted after copy completes

%LaserCOPY-I-START, File copy starting

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 17.8 seconds

%LaserCOPY-E-DELETE, Couldn't delete file, status = 98970

new_laser_file-d-search, result is 0

%LaserCOPY-E-FAILED, Copy failed

[NOTE: File delete failed due to incorrect protection setting under VMS, so the write operation was rerun as is seen below. This time nothing is done to the magnetic disk files after copying to optical, until the protection can be fixed.]

7. Copy a file to jukebox

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8. Dismount disk in jukebox
13. Spawn a sub-process
14. Exit

what would you like to do?

7

```

3274636 blocks available on optical disk
%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /
SIA0:[SEAPAK.CDF]46*_GROUP3.C*;
1 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1 9
2 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1 6
%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /
SIA1:[SEAPAK.CDF]46*_GROUP6.*;
3 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1 9
4 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1 6
%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /
/

```

30 blocks in selected files

3273636 blocks available on optical disk

%LaserCOPY-I-OKALL, Accept all names for copy?

y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to
optical disc [delete, rename, nothing]

NOTHING

%LaserCOPY-I-START, File copy starting

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 3.5 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 2.4 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 2.1 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 2.1 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-END, File copy complete

A variation of the above scenario occurs when you want to select only certain files from a specified group for copying. You will be prompted for what to do with each file individually. Typing "y" will result in it being copied, while typing "n" or hitting a carriage return will result in the file not being copied:

what would you like to do?

7

1720716 blocks available on optical disk

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

sia0:[seapak.cdf]60*_group6.c*;

1 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDF;1 9

2 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

/

15 blocks in selected files

1719716 blocks available on optical disk

%LaserCOPY-I-OKALL, Accept all names for copy?

n

1 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDF;1 9 ?

2 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1 6 ?

y

6 blocks in selected files

1719716 blocks available on optical disk

%LaserCOPY-I-ADJUST, Adjust files after successful copy to optical disc [delete, rename, nothing]

nothing

%LaserCOPY-I-START, File copy starting

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 2.5 seconds

new_laser_file-d-search, result is 0

%LaserCOPY-I-END, File copy complete

7. Copy a file to jukebox

8. Dismount disk in jukebox

13. Spawn a sub-process

14. Exit

- Choice 8 - "Dismount disk in jukebox" - This performs a logical dismount of the disk only. Option 3 in the main menu would still need to be run to physically remove the disk from the drive. The user is returned to the main menu following choice 8's selection.

- Choice 13 - "Spawn a sub-process" - This brings the user into DCL as a sub-process of the main JUKE_MANAGER process. Typically the user may want to check file locations on the magnetic disk or, in the case of an open optical disk, the current inventory of files on the disk. When doing this, the user should remember that, for an open disk mounted, the laser drive is considered a virtual device so that the device name on the host system will typically appear as QSB0 or QSB1, even though the physical device might be LDB0 or LDB1. A sample exchange follows:

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what would you like to do?

13

Juke-Spawn>dir OPTICAL:[coads_mstg1]

[NOTE: The logical name OPTICAL replaces the need to know the actual device name (which is actually QSB0: or QSB1:).]

Directory QSB0:[COADS_MSTG1]

4601-4912_COADS_MSTG_GROUP3.CDF;1

4601-4912_COADS_MSTG_GROUP3.CDH;1

4601-4912_COADS_MSTG_GROUP4.CDF;1

4601-4912_COADS_MSTG_GROUP4.CDH;1

Total of 4 files.

Juke-Spawn>lo

Process SONY_1 logged out at 30-DEC-1988 13:23:31.68
Back in Juke_Manager

7. Copy a file to jukebox

8. Dismount disk in jukebox

13. Spawn a sub-process

14. Exit

- Choice 14 - "Exit" - This exits the JUKE_MANAGER entirely, performing only a logical dismount of the disk and returning the user to DCL. The exchange with the host will resemble the following:

what would you like to do?

14

%LaserMOUNT-W-DISMOUNT, Dismounting volume ENVDATA0004
\$

g. Choice 9 - "Close out completed disk" - This will finalize the writing of files to the current side of the disk. The binary file list, containing an accounting of all files written to the current side, is copied from magnetic disk to the optical disk and renamed to have a name of "(Optical disk volume name).DOC". A sample exchange follows:

what would you like to do?

9

enter project [ENVDATA]

enter category [COADS]

Are you really sure? [n]

[NOTE: You can change your mind and return to the main menu.]

1. Insert disk into jukebox

2. Register disk in jukebox

3. Remove disk from jukebox
4. Check jukebox/database for consistency
5. Initialize disk in jukebox
6. Mount an open project disk in jukebox
9. Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

what would you like to do?

9

enter project [ENVDATA]

enter category [COADS]

Are you really sure? [n]

y

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

%LaserCOPY-I-COPY, Copying file

DUA0:[OPTICAL.SOAR]ENVDATA0004.DOC;1

%LaserCOPY-I-TIMING, Copy completed in 2.2 seconds

new_laser_file-d-search, result is 0

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

%MOUNT-I-MOUNTED, mounted on _DIATOM\$LDB0:

h. Choice 10 - "Mount a disk in jukebox" - This is used to do a software or logical mount of either an open or closed disk for the purpose of reading or checking files from it. This choice is similar to choice 6 except that the user cannot write files to the Sony. A sample exchange follows:

what would you like to do?

10

%LaserMOUNT-I-LABEL, Volume name of disk to mount ENVDATA0001

disk size is 3276000

disk registered by JIMF

at archive site GSFC-OCEANS on 8-DEC-1988 16:03:37

using software JUKEPACK 1.0

with serial no. 1
and disk name GSFC-OCEANS000001
%MOUNT-I-MOUNTED, ENVDATA0001 mounted on _DIATOM\$QSB0:

- 8. Dismount disk in jukebox
- 13. Spawn a sub-process
- 14. Exit

what would you like to do?

At this point, the user may choose item 13 to spawn a sub-process, then use a "dir" command to check the files on the disk, or possibly "copy" to move files to magnetic disk from the Sony.

i. Choice 11 - "Read in selected files" - This follows the mounting of an open or closed disk using choices 6 or 10, and is used for copying certain files to magnetic disk from the Sony drive. A sample exchange follows:

what would you like to do?

11
Enter search pattern or / to stop searching
46*_group3.c*
Searching via pattern "46*_GROUP3.C*"
1 [COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDF;1 on
ENVDATA0004 <online>
2 [COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDH;1 on
ENVDATA0004 <online>
Enter search pattern or / to stop searching
/
All matches approved for copy?
y
Where do you want the files written?
sial:[seapak.cdf]
disk size is 3276000
disk registered by SONY
at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14
using software JUKEPACK 1.0
with serial no. 4
and disk name GSFC-OCEANS000002
found volume label
%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$LDB0:
%LaserCOPY-I-COPY, Copying file
LDB0:[COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDF;1
%LaserCOPY-I-TIMING, Copy completed in 2.7 seconds
%LaserCOPY-I-COPY, Copying file
LDB0:[COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDH;1
%LaserCOPY-I-TIMING, Copy completed in 2.2 seconds

A variation of the above occurs when the user selects a group of files then decides to read only certain ones in the group:

what would you like to do?

11

Enter search pattern or / to stop searching

0179_0679_fnoc_uv.c*

Searching starting with "0179_0679_FNOC_UV.C"

1 [WINDS1]0179_0679_FNOC_UV.CDF;1 on ENVDATA0001

<online>

2 [WINDS1]0179_0679_FNOC_UV.CDH;1 on ENVDATA0001

<online>

Enter search pattern or / to stop searching

/

All matches approved for copy?

n

[WINDS1]0179_0679_FNOC_UV.CDF;1 ?

y

[WINDS1]0179_0679_FNOC_UV.CDH;1 ?

n

1 [WINDS1]0179_0679_FNOC_UV.CDF;1 on ENVDATA0001

<online>

All matches approved for copy?

y

Where do you want the files written?

sial:[sony]

disk size is 3276000

disk registered by JIMF

at archive site GSFC-OCEANS on 8-DEC-1988 16:03:37

using software JUKEPACK 1.0

with serial no. 1

and disk name GSFC-OCEANS000001

%MOUNT-I-MOUNTED, ENVDATA0001 mounted on _DIATOM\$QSB0:

%LaserCOPY-I-COPY, Copying file

QSB0:[WINDS1]0179_0679_FNOC_UV.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 2.9 seconds

1. Insert disk into jukebox
2. Register disk in jukebox
3. Remove disk from jukebox
4. Check jukebox/database for consistency
5. Initialize disk in jukebox
6. Mount an open project disk in jukebox
9. Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

what would you like to do?

j. Choice 12 - "Write out selected files" - This is used for copying certain files from magnetic disk to the Sony drive. This choice will mount the disk with the specified project and category

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and then prompt the user for the filenames to be copied, then dismount the disk when the user indicates they are finished. If no appropriate disk is currently available to write the files to, the user will be prompted for a fresh disk, which will be inserted, registered and initialized (if necessary). The effect is similar to choosing number 6 from the main menu to mount the disk, followed by choice 7 in the submenu to write to the disk and then choice 8 in the submenu to dismount the disk. One advantage of using the second method is the option to spawn a sub-process (submenu choice 13) in order to check magnetic disk directories, etc. A sample exchange follows:

what would you like to do?

12

enter project

ENVDATA

enter category

COADS

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

sia0:[seapak.cdf]70*_group6.c*;

1 SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDF;1 9

2 SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

/

15 blocks in selected files

%LaserCOPY-I-OKALL, Accept all names for copy?

y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to optical disc [delete, rename, nothing]

nothing

%LaserCOPY-I-START, File copy starting

* see if open project disc is available

* mount open disc for write: ENVDATA0004

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on DIATOM\$QSB0:

* file size 9, space left 1355140

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 4.2 seconds

new_laser_file-d-search, result is 0

* file size 6, space left 1355132

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 4.2 seconds

new_laser_file-d-search, result is 0

%LaserCOPY-I-END, File copy complete
%LaserCOPY-I-DMOUNT, Dismount disk

k. Choice 13 - "Spawn a sub-process" - This is the same as the description for choice 13 above which is in the submenu when an open disk is mounted (main menu choice 6). The only difference is that typing "lo" to terminate the sub-process here will return the user to the main JUKE_MANAGER menu.

l. Choice 14 - "Exit" - This exits the JUKE_MANAGER entirely. Note that this only does a logical dismount of the disk. As a result, the JUKE_MANAGER will think the disk is still in the drive the next time it is invoked. This can be remedied by running main menu choice 3 (remove disk) before choice 14. This will also do the physical dismount for removing the disk from the drive.

IV. SUMMARY OF PROCESSING SEQUENCES FOR READING, WRITING AND CHECKING OPTICAL DISKS

This section summarizes the order of operations which should be performed to read or write optical disks. Separate subsections are included for disks which are open, closed and blank.

1. Reading files from an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #11 (read in files).
- d. decide which files will be read in (the RDB database will be searched for these names).
- e. specify disk and directory destination for these files.
- f1. if disk in Sony is incorrect, disk will be ejected and proper disk will be requested.
- f2. if the other side of disk in Sony is the correct one, the disk will be ejected with a request to flip it over.
- g. disk will be mounted and files copied to the specified destination.
- h. if files span more than one side of a disk, the current disk will be ejected and the next disk/side will be requested as per f1 and f2 above.
- i. after all files have been read in the disk will be dismounted.
- j. select main menu #3 (remove disk) - disk will be ejected.
- k. select main menu #14 (exit JUKE_MANAGER).

2. Reading files from a CLOSED optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #11 (read in files) - follow the prompts.

- d. decide which files will be read in (the RDB database will be searched for these names).
- e. specify disk and directory destination for these files.
- f1. if disk in Sony is incorrect, disk will be ejected and proper disk will be requested.
- f2. if the other side of disk in Sony is the correct one, the disk will be ejected with a request to flip it over.
- g. disk will be mounted and files copied to the specified destination.
- h. if files span more than one side of a disk, the current disk will be ejected and the next disk/side will be requested as per f1 and f2 above.
- i. after all files have been read in the disk will be dis-mounted.
- j. select main menu #3 (remove disk) - disk will be ejected.
- k. select main menu #14 (exit JUKE_MANAGER).

3. Writing files to a BLANK optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #2 (register disk).
- d. select main menu #5 (initialize disk).
- e. select main menu #6 (mount open disk) or #12 (write out files).
- f. select submenu #7 (copy file) after main menu #6, or follow prompts after main menu #12. Either choice will prompt for the file names to be written out and what to do with them after successful writing (rename, delete, nothing), and main menu #12 will also prompt for the project/category. The files will be written out one at a time. If the next file in sequence will not fit on the current open disk, then the open disk will be closed, and operations will continue as described in "Notes" below beginning at the asterisk.

[Notes on mounting of disk: If an open project disk is available, it will be mounted if in the drive. If this disk is not in the drive, the disk in the drive will be ejected and an open disk will be requested. *If no open disk is available, a registered disk will be requested (if available). If a registered disk is requested but none is available, a blank disk will be requested and will be initialized.]

- g. select submenu #8 (dismount disk) (after main menu #6 only; main menu #12 will do this for you).
- h. select main menu #3 (remove disk) - disk will be ejected.
- i. select main menu #14 (exit JUKE_MANAGER).

4. Writing files to an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.

- c. select main menu #6 (mount open disk) or #12 (write out files).
- d. select submenu #7 (copy file) after main menu #6, or follow prompts after main menu #12. Either choice will prompt for the file names to be written out and what to do with them after successful writing (rename, delete, nothing), and main menu #12 will also prompt for the project/category. The files will be written out one at a time. If the next file in sequence will not fit on the current open disk, then the open disk will be closed, and operations will continue as described in "Notes" below beginning at the asterisk.

[Notes on mounting of disk: If an open project disk is available, it will be mounted if in the drive. If this disk is not in the drive, the disk in the drive will be ejected and an open disk will be requested. *If no open disk is available, a registered disk will be requested (if available). If a registered disk is requested but none is available, a blank disk will be requested and will be initialized.]

- e. select submenu #8 (dismount disk) (after main menu #6 only; main menu #12 will do this for you).
- f. select main menu #3 (remove disk) - disk will be ejected.
- g. select main menu #14 (exit JUKE_MANAGER).

5. Writing files to an CLOSED optical disk with the JUKE_MANAGER

This cannot be done.

6. Checking files on an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #6 (mount open disk).
- d. select submenu #13 (spawn a sub-process).
- e. execute the command "dir OPTICAL:[(dir name)](filenames)" to check for existence of files.
- f. terminate the sub-process by typing "lo" when finished.
- g. select submenu #8 (dismount disk).
- h. select main menu #3 (remove disk) - disk will be ejected.
- i. select main menu #14 (exit JUKE_MANAGER).

7. Checking files on a CLOSED optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #13 (spawn a sub-process).
- d. execute the command "dir OPTICAL:[(dir name)](filenames)" to check for existence of files.
- e. terminate the sub-process by typing "lo" when finished.
- f. select main menu #3 (remove disk) - disk will be ejected.
- g. select main menu #14 (exit JUKE_MANAGER).

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8. Checking/reading files on OPEN or CLOSED optical disks without the JUKE_MANAGER

[NOTE: At NASA/GSFC Laboratory for Hydrospheric Processes, this can be done from any user account on node DIATOM, because the setup procedure has been modified so as not to check privileges. No special privileges are needed for reading only.]

- a. physically insert disk into drive, with the side to read facing down.
- b. Goddard "SEAPAK" users: type "sonym 0" (for drive DIATOM::LDB0) or "sonym 1" (for drive DIATOM::LDB1) to mount and set up the disk for reading.

OR

- b. non-SEAPAK users: type in the DCL sequence described under "Starting Up the JUKE_MANAGER" subsection above. Add the following:

```
$mount /over=id (drive name, i.e. ldb0: or ldb1:) /noassist
```

- c. execute the DCL command
"dir ldb0(or ldb1):[(dir name)](filenames)" to check for existence of files, or use the "backup" or "copy" command to copy files to magnetic disk. You can also print the .DOC file in LDB0:[000000] or LDB1:[000000] for a file list. Goddard users note: Copying CZCS archive files from the Univ. of Miami platters takes about 7 seconds per file.
- d. Goddard "SEAPAK" users: type "sonyd 0" or "sonyd 1" to logically dismount and spin down the disk; use the "Emergency eject" button on the left side of the drive unit to physically remove the disk from the Sony.

OR

- d. non-SEAPAK users: from DCL type "dism ldb0:" followed by "a eject" to physically eject the disk.

V. THE UTILITY PROGRAM "A"

This program is available from privileged accounts only. The options are:

1. Type "a eject" to physically eject the platter before logging out.
2. Type "a stop" to spin down the platter. This is also done when you use the "dismount" command in DCL.
3. Type "a start" to spin up a platter.

4. Type "a sense" to see if the controller is working. A code 0 means everything is normal, while a code 6 means there is a controller error.
5. Type "a inquire" to get information on the type of media in the drive. A sample output follows:

Write-Once Read-Multiple Vendor: SONY Product: WDC-2000-10
Rev: 1.00
Removable media
Disk loaded

Acknowledgements: Thanks to Jim Brown at the University of Miami and Gene Feldman at NASA/GSFC for their assistance in using the Sony WORM disk drive.

DATA PROCESSING DESCRIPTIONS

- A. Logging On and Displaying an Image**
- B. Ingesting Level-1 Data**
- C. Generating CZCS Level-2 Products**
- D. Projecting Multiple Images to a Common Map**
- E. Using STATDIS to Generate Images from Image Data Files**
- F. Formats of SEAPAK Image and Control Point Files**
- G. Environmental Data Processing Scenarios**

LOGGING ON AND DISPLAYING AN IMAGE

The basic steps to display an image on the IIS are:

- 1) Select CPU corresponding with the IIS being used
- 2) Log onto the computer
- 3) Enter "SEAPAK"
- 4) Allocate an IIS
- 5) Initialize the IIS
- 6) Use the program IMAGE to display the desired image
- 7) If another image is to be displayed, repeat step 6
- 8) When finished, log off

The detailed steps to accomplish this vary depending on the TAE mode one is using, i.e. the Menu, Tutor or Command mode. A brief description for each of these modes follows. See the earlier section describing TAE for more information. Detailed descriptions of individual programs are given elsewhere in this guide.

MENU MODE:

- 1) Selecting a CPU via a Decserver:
 <Carriage Return> <---- This gets the Decserver's
 attention
 ENTER USERNAME> Name <---- Enter the user's name
 LOCAL> Connect CPU Name <---- Enter the CPU name
 after typing
 "Connect" (or "C")
- 2) Logging onto the VAX:
 USERNAME: Account Name <---- Enter the account
 name here
 PASSWORD: Password <---- Enter password here
- 3) Entering SEAPAK:
 \$SEAPAK <---- This activates SEAPAK if the user's
 LOGIN.COM file has been setup properly
 with all the symbols defined.
 SEAPAK>MENU <---- This puts SEAPAK into the Menu
 Mode. Note that the abbreviation
 "M" is sufficient.

To understand the input numbers in what follows, check the menu tree. The individual programs and their associated parameters are described in detail in the Reference section of this manual.

- 4) Allocating an IIS (numbers represent items in the menu which are subject to change):
 ? 1 <---- Selects the SEAPAK menu
 ? 5 <---- Selects the IIS image display menu

- ? 1 <---- Selects the IIS initialization menu
- ? 1 <---- Selects the program ALLOC which reserves a specific IIS for the user. Enter the parameter requested and type RUN.
- 5) Initializing the IIS:
 - ? 2 <---- Selects the program INT from the INITIAL menu. This initializes the IIS. Enter the parameter requested (CLRMEM=YES) and type RUN.
- 6) Displaying an Image on the IIS:
 - ? BACK <---- This moves the user from the INITIAL menu to the DISPLAY menu.
 - ? 2 <---- This selects the IIS memory management menu.
 - ? 1 <---- Selects the program IMAGE which drops or displays an image on the IIS. Enter the parameters requested and type RUN.
- 7) If one wants to display more images:
 - ? 1 <---- This will select IMAGE again
- 8) If one wants to log off the computer:
 - ? LO <---- This will log the user off.

TUTOR MODE:

- 1) Selecting the proper CPU, logging on and entering SEAPAK are the same as for the Menu mode except one does not type MENU to get into the Menu mode.
- 2) Allocating an IIS:
 - SEAPAK>TUTOR ALLOC <---- This puts one into the tutor or menu mode for the program ALLOC which reserves a specific IIS for the user. Enter the parameter requested and type RUN. Note that "Tutor" can always be abbreviated by "T".
- 3) Initializing the IIS:
 - SEAPAK>TUTOR INT <---- This puts one into the tutor or menu mode for the program INT. Enter the parameter requested (CLRMEM=YES) and type RUN. This initializes the IIS.

- 4) Displaying an Image on the IIS:
SEAPAK>TUTOR IMAGE <---- This puts one into the tutor or menu mode for the program IMAGE which drops or displays an image on the IIS. Enter the parameters requested and type RUN.
- 5) Repeat step 4 if one wants to display more images. If ready to log off:
SEAPAK>LO

COMMAND MODE:

- 1) Selecting the proper CPU, logging on and entering SEAPAK are the same as for the Menu mode except one does not type MENU to get into the Menu mode.
- 2) **SEAPAK>ALLOC ATLANTIC** <---- Allocates the IIS named Atlantic. If one is using Pacific, type this rather than Atlantic.

SEAPAK>INT YES <---- This initializes the IIS.

SEAPAK>IMAGE Image_File_Name IIS_Channel_Number
<---- This displays the specified image file in the given IIS channel.
SEAPAK>LO <---- If one wants to log off; else, repeat the "IMAGE" command if there are more to display.

INGESTING LEVEL-1 DATA

In this section, the generation of CZCS and AVHRR level-1 images from tape files will be discussed. The CZCS level-1 files normally have 970 scan lines per file, but may have fewer, and 1968 samples per scan line. Level-2 products from the CZCS must be generated separately (see the section on generating CZCS level-2 products). The programs TP2IMG and TP2DSK are used to create 512x512 disk image files from level-1 tape files of CZCS and DK2IMG creates such image files from level-1 disk files. However, TP2DSK may also be used for to ingest up to three complete 970x1968 (full-scan) CZCS scenes from a tape as one set of files from which 512x512 image files may be extracted using the program WINDOW. This approach is often more convenient than using TP2IMG or DK2IMG since it permits the user to visually determine the location of the extracted image in the overall scene.

Unlike CZCS files, AVHRR tape files from NOAA can be any number of scan lines. Also, the AVHRR local area coverage (LAC) data has 2048 and global area coverage (GAC) data has 409 samples per scan line. Sea-surface temperature (SST) level-2 products are created when the AVHRR data ingest program AV2IMG is used.

See the individual help sections of the programs mentioned for more detailed information.

Using TP2IMG and DK2IMG: The programs TP2IMG and DK2IMG are used to ingest individual level-1 CZCS scenes and create 512x512 pixel images. Both programs work the same way except that TP2IMG uses tape files as input whereas DK2IMG requires disk input files. In addition to the creation of full-resolution images (reduction factors of 0), positive reduction factors may be used to subsample the data, since the level-1 scene may have up to 970 scan lines of 1968 samples, and negative reduction factors may be used to create images magnified by pixel duplication. Using TP2IMG and DK2IMG requires a little arithmetic unless one assumes the file is a full scene and an overview is desired (reduction factors 4 and 2 for samples and scans, respectively). Usually, a user will want to generate a set of overview images in order to see the full scene. From the overview images, the coordinates of subimages can be determined and they are usually used in the Angstrom exponent determinations required by the level-2 programs discussed in the section on generating CZCS level-2 products.

In SEAPAK, image files of each CZCS band are created independently of the others. Systems like the University of Miami's DSP interleave the data from each channel resulting in one file per scene(s). SEAPAK creates six image files and one control point file which contains the navigation data. For TP2IMG and DK2IMG, the user provides a root name and extension for the image files and the band numbers are appended to the root name automatically. The control point file is simply the root name with a ".CTL" extension (rootname.ctl). Each file format convention has its advantages and

disadvantages. Separation of the image files allows users to easily delete unnecessary files, such as IR-band images, thus saving disk space, but requires more file management.

Finally, if the subscene the user is interested in spans more than one scene, MERGE can be used to combine several scenes into one 512x512 image, subsampling if necessary.

Using TP2DSK and WINDOW: Rather than ingesting reduced-resolution CZCS scenes one at a time to obtain an overview and then reading in subscenes for merging as described above, the combination of the programs TP2DSK and WINDOW may be used. For TP2DSK, all one needs to specify are the sequence number of the first file and the number of files to be read from the tape. The files must be consecutive satellite scenes as they normally are on tapes obtained from NASA or NOAA. The output is one large file containing the scenes' data at full-resolution. If significantly large gaps exist between the scenes, execution will not be completed. Currently, up to three files can be ingested in this way.

The program WINDOW is very easy to use. The IIS memory is utilized in such a way that the entire data file may be roamed at full resolution or displayed as an overview at reduced resolution by simply toggling a button. The user defines a box using the IIS button pad which will have dimensions that are multiples of 512 pixels in each direction. Single images from one CZCS band or all the bands can be generated that correspond to the current box position. When the appropriate function key is depressed, the user will be prompted for the filenames required. The program automatically uses the boxed area to create a 512x512 sized image, subsampling if necessary.

Using AV2IMG: This program is used to ingest an AVHRR scene of HRPT, LAC or GAC data from a tape in the format of those generated by NOAA/NESDIS/NCDC/SDSD (Kidwell, 1988) as well as to generate the SST image. The data must be in packed format, with time incrementing, and be a full set copy (as opposed to selective extract subsets where certain channels are selected). Unlike CZCS scenes, the AVHRR scene in this format may contain variable scan line numbers. The program allows the user to scan the tape scene first, if the user has no information of the input scene, in order to get the starting and ending scan line numbers for the windowing and reduction factor parameters. Also, since the AVHRR scenes may be obtained while the satellite is ascending (flying south to north) or descending (north to south), the enumeration of the samples and scan lines may be reversed. See the TPAVHRR program section for more detailed information.

GENERATING CZCS LEVEL-2 PRODUCTS

The SEAPAK CZCS level-2 menu includes a number of tools to assist the user in determining the input parameters required to generate level-2 products. Only a few are normally employed in the routine production of level-2 products (usually THRES, CLRWAT, and L2MULT), while several of the others are special purpose programs (L2DUAL, L2GAC, EPSILON and L2BOXD). L2MULT, L2SNGL and L2DUAL create images of subsurface water radiance (or, optionally, normalized water-leaving radiance) at 443nm, 520nm and 550nm, aerosol radiance at 670nm, pigment concentration and Rayleigh radiance at 443nm. In this discussion, the term "water radiance" will apply to subsurface water radiance, while water-leaving radiance and normalized water-leaving radiance refer to radiances just above the air-water interface. These will be discussed in more detail later. A selection of Rayleigh scattering models is available and include single scattering (L2SNGL) and two multiple scattering methods (L2MULT). The multiple scattering model of Gordon et al. (1988) is recommended since it is the most sophisticated model available for CZCS analysis and is the model used in the CZCS global processing project (Esaias et al., 1986; Feldman et al., 1989). While the Rayleigh radiances are not standard global processing products, SEAPAK includes the 443 Rayleigh radiance field because it is a useful diagnostic quantity when other standard products seem unreasonable. Also, SEAPAK does not generate the diffuse attenuation field K(490), which is a standard global processing product, since there has not been a demand for it by any of the GSFC investigators using SEAPAK.

L2BOX and L2BOXD allow the user to roam a scene using the cursor and compute the values of the level-2 products within a box while providing the flexibility of changing input parameters such as the calibration correction factors, the aerosol correction parameters and the ozone optical thicknesses. Other products such as images of the epsilon values in 443nm, 520nm and 550nm can be generated using EPSILON by making certain assumptions about the water radiance fields.

The primary parameters required for generating level-2 products are the aerosol correction parameters (the Angstrom exponents or epsilons) and the land/cloud and aerosol flag thresholds. Programs such as CLRWAT, SCREEN, and ANGST are designed to help determine the aerosol correction parameters while THRES may be used to fine tune the land/cloud and aerosol flags.

Other parameters, such as the calibration correction factors and the ozone optical thicknesses, can also be varied. However, the use of calibration correction factors other than the default values is not recommended since such factors are not easily determined unless additional field observations of upwelling water radiance are available. Likewise, alternate ozone thicknesses should be used with caution since the default thicknesses are derived from the Total Ozone Mapping Spectrometer (TOMS) data for

the time and location of the scene in question. Once the level-2 products are created, the land/cloud thresholds may be modified using FLAGLC and LANCLD to create new versions of the images without rerunning the level-2 program. If the user wishes to use a standard set of input parameters on a group of scenes, SPBATCH can be used to run all the jobs at once in a batch mode. In this section, a typical sequence of steps for generating standard level-2 images from a set of level-1 images will be discussed.

Step 1: Determining the Angstrom exponents and the land/cloud flags. In the global CZCS processing mentioned above, Angstrom exponents equal to 0 are used on all scenes and no attempt is made to compute Angstrom exponents for each scene. The terms Angstrom exponent and epsilon are both used interchangeably in discussing the aerosol correction. The reader is referred to Gordon et al. (1983) for a discussion of the terms which are related by the following equation:

$$e(\lambda) = (\lambda/670)^{n(\lambda)}$$

where λ is the wavelength (443, 520 or 550), and $e(\lambda)$ and $n(\lambda)$ are the epsilon and Angstrom exponent, respectively. So, for an epsilon equal to 1, the Angstrom exponent is 0. As epsilon increases, the Angstrom exponent becomes more negative. One of the assumptions in the atmospheric correction algorithm is that the aerosol radiance at 670nm is related to the aerosol radiances at 520nm and 550nm through this equation. Another assumption is that these do not change within a scene. The Angstrom exponent at 443nm is taken to be the average of the values at 520nm and 550nm because the water radiances at 443nm are too variable even in clear water for stable estimates to be derived.

In areas dominated by marine haze such as in the central gyres and along the western continental margins, Angstrom exponents of 0 (or epsilons of 1) are usually adequate. However, in regions influenced by continental haze such as the eastern U.S. coast and the Mediterranean Sea, these values often fail to remove the haze resulting in contamination of the level-2 products by underestimating the aerosol radiance. This produces an overestimation of the water radiance and an underestimation of pigment concentration. On the other hand, high concentrations of dust are often encountered in the eastern tropical Atlantic Ocean, the western Pacific Ocean, and the Arabian Sea. These conditions can cause the 670nm band to saturate making an atmospheric correction impossible. The HAZE parameter (of program L2MULT, for example) has a default value of 254 which flags all saturated pixels, although some conditions may require the flag to be set lower. Dust contaminated data usually require Angstrom exponents greater than zero. One should always compare the water radiance and pigment images with the aerosol radiance or level-1 670nm radiance image to determine if features are correlated. If the haze is correctly removed, there should be no correlation.

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When dense or continental haze is present, the user may try CLRWAT in an attempt to find a better set of Angstrom exponents. CLRWAT is described in the program reference volume of this manual. CLRWAT has two modes, user-interactive and automated and uses a set of criteria to eliminate pixels from consideration. Some of these criteria may be adjusted by the user. Solar zenith and spacecraft zenith angles are examples. If the sun is too low in the sky, the radiative transfer models may not work well enough for the estimation of the Angstrom exponents. Aerosol radiance is another example. If the haze is too dense or too small, the estimation of the Angstrom exponents will not be valid for the rest of the scene. Also, pixels which fail the land/cloud flag are eliminated. Defaults settings are provided for all these. In the interactive mode, the user roams the scene with a box cursor looking for the set of Angstrom exponents associated with the lowest value of a quantity called CLOW. CLOW is the ratio $e(443)/La(670)$ where $La(670)$ is the aerosol radiance.

This procedure was developed by the Nimbus Experiment Team (NET) and is presented in Williams et al. (1985), but the rationale behind it was never discussed. It has been used by SEAPAK users for several years and has been found to yield consistent and quite acceptable results (see Barale et al., 1986, and McClain et al., 1988). The best locations to search are those with very low pigments because the 670nm radiances will not be affected by the ocean's reflectance. Care must be taken to avoid pixels affected by sensor ringing on the down-scan side of bright areas such as clouds (Mueller, 1988; see the help text for the program RING), an effect that is most noticeable in the 670nm image. In addition, fringe areas around clouds that are not flagged by the land/cloud threshold can cause erroneous estimates of CLOW.

In the automated mode, the user sets the maximum pigment threshold in order to ensure that clear-water pixels are used. The program then computes the epsilon frequency distributions at 443nm, 520nm and 550nm from all valid pixels. Certain statistics are derived from the frequency distributions and may be output to a text file. These include the minimum, the maximum, the mean, the median, the mean of the lowest 10%, and the standard deviation. From these, the user can select a set of epsilon values to use. The automated mode also creates a special image whose pixel values indicate the rejection criterion for invalid pixels as well as the clear-water pixels that passed all criteria. This special image may be displayed using the program SCREEN to color the various pixels according to each pixel's category.

When using CLRWAT, care must be taken to set the cloud threshold properly. The default works in most situations, but care must be taken to avoid thin clouds and areas where the 670nm radiances are saturated. Band 5 (750nm) was designed for land/cloud identification. Clouds at low solar elevations tend to be less bright, so if the solar zenith angle is high (the program DMPHDR can be used to find out) or if there are a lot of thin clouds, the default value of 21 counts (gray levels) in the 750nm image may need to be reduced. THRES or READ can be used to

determine the "best" threshold. In general, it is advisable to use the level-1 670nm image for the interactive use of CLRWAT because it is sensitive to haze, clouds and ringing.

If CLRWAT does not yield useful results, ANGST is often helpful. ANGST is based on a technique developed by Arnone and LaViolette (1984) and is designed to allow the user to interactively remove haze from the level-1 443nm, 520nm and 550nm bands using the 670nm band as the reference aerosol band. In ANGST, one operates on each band separately using the trackball to fine tune the haze removal. This is particularly useful when there is a specific haze feature to be removed. In this way, incremental increases in the Angstrom exponents can be made until there is no evidence of the feature left in the water radiance images. The program allows the user to check the water radiance values in the scene using the cursor and to stretch the image contrast in order to see more clearly the features. In using the level-2 programs which require Angstrom exponents, the same Rayleigh scattering model must be used as was used in determining the Angstrom exponents.

Step 2: Using L2MULT. (See the detailed description of L2MULT in the programs volume for more information on options and parameters). Once the Angstrom exponents and the land/cloud flag are determined, L2MULT is used to generate the level-2 products. In L2MULT, two multiple scattering algorithms are available and are selected using the MULTIS parameter. The "exact" option is recommended. The program is designed to provide as much flexibility as possible in the selection of algorithms and input parameters. An inexperienced person should stick with the defaults provided for parameters such as the ozone optical thicknesses, the calibration algorithm, the multiple scattering algorithm, the pigment algorithm, water radiance range and the method used for the aerosol correction (ITERATE is the selection parameter).

The user is given the choice of generating subsurface upwelling water radiance or normalized water-leaving radiance (Gordon and Clark, 1981) images. The parameter is NORMWAT. The transformation from subsurface water radiance to water-leaving radiance is a function of the Fresnel reflectivity and the index of refraction. However, it is wavelength independent and cancels out when ratios are used in the pigment algorithm. Normalized water-leaving radiances have the solar zenith angle dependence removed and therefore have the advantage of being nearly constant at 520nm and 550nm in clear water regions. The normalized 443nm water-leaving radiances are variable because of the great sensitivity to pigment concentration at 443nm, even in clear water regions. At this time, algorithms for deriving other quantities from normalized radiances have not been developed. Finally, the user is given the option of applying the Smith and Wilson (1981) iteration method for computing the water and aerosol radiance fields. This option creates a seventh output field for water radiance at 670nm since it does not assume that water radiance at 670nm is zero as does the Gordon et al. (1983) algorithm. For each pixel, if the algorithm

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does not converge after 10 iterations, it is assumed to be an invalid pixel and a 0 gray level (black) is assigned to all output images at that pixel.

One input which may require some advance consideration is the cloud flag. In L2MULT, the 443nm level-1 radiances are used with the 750nm (band 5) radiances to discriminate land from clouds if the MASKLC parameter is set to "YES". In this case, pixels which are brighter than the CLOUD threshold gray level value and which are also flagged by the LANCLD threshold will be set to a 255 gray level (white) in the level-2 images. Pixels which fail the LANCLD threshold, but pass the CLOUD threshold are set to a 0 gray level value. If the CLOUD threshold used results in black areas over the ocean, this pixels may be changed to 255 values using LUTMOD (described in the programs volume) with having to regenerate the level-2 products. Also, if the threshold for the LANCLD parameter was not optimal, the program FLAGLC or LANCLD can be used to modify the level-2 images.

There are two pigment algorithms from which to select. The parameter is PIGMENT. One is the standard, two-channel "branching" algorithm of Gordon et al. (1983). This algorithm switches from an equation based on water radiances in the 443nm and 550nm bands to one based on the 520nm and 550nm bands once the concentration reaches 1.5. In this case, SEAPAK also switches to the 520nm-550nm equation once the 443nm subsurface water radiance drops below 0.15. This is done because of imperfections in the switching logic which occasionally allow the 443nm-550nm combination to be used even though it yields values much greater than 1.5. The exact algorithm as implemented in SEAPAK is

1. if $L_w(550) \leq 0$, then $P = 40.84719$ (saturated); else,
2. if $L_w(443) > 0.15$,
 then $P = A_2 * (L_w(443)/L_w(550))^{B_2}$, (A)
 where $\log_{10}(A_2) = 0.053$ and $B_2 = -1.71$;
 if $P \geq 1.5$ and $L_w(520) > 0$
 then $P = A_4 * (L_w(520)/L_w(550))^{B_4}$, (B)
 where $\log_{10}(A_4) = 0.522$ and $B_4 = -2.44$;
 if $P < 1.5$, then use (A) above;
3. if $L_w(443) \leq 0.15$ and $L_w(520) > 0$, then use (B) above;
4. if $L_w(443) \leq 0.15$ and $L_w(520) \leq 0$,
 then $P = 40.84719$ (saturated);

where L_w represents the water-leaving radiance for the band of the specified wavelength (nm) and P is the pigment concentration in mg/m^3 .

The other algorithm uses a three-channel equation provided by Dennis Clark (see Muller-Karger et al., 1990):

1. if (Lw(550)>0) and (Lw(443)>0 or Lw(520)>0), then
 RATIO = [max(Lw(443),0) + max(Lw(520),0)] / Lw(550)
 P = 5.56 * RATIO**(-2.252); else,
2. P = 40.84719 (saturated).

This algorithm does not involve a switching of equations that often results in a minimum for the pigment frequency distribution of the two-channel algorithm.

Finally, L2MULT and several other programs including CLRWAT and ANGST allow the user to change the calibration of bands 1 to 4. In the case of multiple scattering, only two options are provided, "Evans" and "User." The parameter is CORR. The CZCS suffered a severe calibration degradation or sensitivity loss which was erratic. Several algorithms were proposed by various investigators to correct for this and all are necessarily coupled to the Rayleigh scattering model they used. The reason for this coupling is that all techniques utilize either direct sea truth measurements or assume clear water radiances over the open ocean and the calibration is adjusted so as to match those values with the assumption that the Angstrom exponents in clear water regions are zero.

The Evans scheme (unpublished; used in the global CZCS processing) is the only one available which corresponds to the multiple scattering model of Gordon et al. (1988). The user should only try defining his own correction factors (FACTOR) when testing the sensitivity of the level-2 products or when he is trying to compare with sea truth observations. These calibration factors only multiply the calibration term as given in Gordon et al. (1983a) and do not change the slope and intercept numbers in that term. The Evans calibration modifies the slopes and intercepts for each gain setting and includes a time-dependent correction factor as well. There must be consistency between the calibration used in deriving the Angstrom exponents and that used in L2MULT.

The conversion of CZCS counts to total radiance (Lt), or calibration, uses the following general equation:

$$Lt(b) = [Counts(b) * SLOPE(b) + INTCP(b)] * FACTOR(b)$$

where SLOPE and INTCP are the equations slope and intercept, FACTOR is the correction factor, and b is a CZCS band (channel) number 1 to 4. For the "Evans" option, SLOPE, INTCP, and FACTOR are calculated as follows:

$$\begin{aligned} SLOPE(b) &= SLP(b,g) * MULTG(b,g) * SMULT(b) * \\ &\quad [C(b,o) - (A(b,o)*Orbit)] \\ INTCP(b) &= INT(b,g) * MULTG(b,g) * IMULT(b) \\ FACTOR(b) &= 1.0 \end{aligned}$$

where SLP and INT are the unmodified calibration slope and intercept, MULTG is a gain-dependent multiplier to SLP and INT,

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Table 1. Values of time-independent "Evans" parameters.

<u>parameter</u>	<u>gain</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
SLP	1	0.04452	0.03103	0.02467	0.01136
	2	0.03589	0.02493	0.02015	0.00897
	3	0.02968	0.02032	0.01643	0.00741
	4	0.02113	0.01486	0.01181	0.00535
INT	1	0.03963	0.05361	0.06992	0.01136
	2	0.03963	0.06361	0.06992	0.01136
	3	0.03963	0.06461	0.08292	0.01136
	4	0.03963	0.06361	0.07992	0.01136
MULTG	1	1.057	0.969	0.958	1.008
	2	1.060	0.970	0.947	1.020
	3	1.050	0.975	0.931	1.016
	4	1.059	0.960	0.934	1.010
SMULT	--	0.983	1.013	1.017	1.000
IMULT	--	1.0	1.0	1.146	1.0

SMULT and IMULT are gain-independent multipliers to SLP and INT, and C and A are the intercept and slope of a time-dependent (orbit number) correction to SLP. The indices g and o represent the sensor gain and orbit. The values of SLP, INT, MULTG, SMULT, and IMULT are listed in Table 1, and those of C and A are listed in Table 2. For the "user" option, SLOPE and INTCP are obtained from Table 3 and FACTOR is as specified by the user.

Once the level-2 products have been created, gray level and geophysical values may be examined using programs such as READ, RLINE and HIST. For linearly scaled quantities, the slope and intercept are stored in the file header and are read by these programs in order to transform gray levels to geophysical values. READ allows the user to roam the image and examine values within a user-defined box or at individual points. RLINE allows the user to examine values along lines and HIST can be used to examine the frequency distributions.

Table 2. Values of time-dependent "Evans" parameters.

<u>par.</u>	<u>orbit no.</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
A	<5001	-1.700E-05	-5.000E-06	-2.000E-06	0.0
	5001-6750	-6.000E-05	-5.000E-06	-2.000E-06	0.0
	6751-20000	-1.457E-05	-9.770E-06	-6.620E-06	0.0
	>20000	-1.700E-05	-6.000E-06	-5.000E-06	-5.000E-06
C	<5001	1.0	1.0	1.0	1.0
	5001-6750	0.785	1.0	1.0	1.0
	6751-20000	1.092	0.967	0.968	1.0
	>20000	1.0426	1.042	0.9995	0.9

Table 3. Slopes and intercepts for "user" option (from Gordon et al., 1983).

<u>parameter</u>	<u>gain</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
SLOPE	1	0.04452	0.03103	0.02467	0.01136
	2	0.03598	0.02493	0.02015	0.00897
	3	0.02968	0.02032	0.01643	0.00741
	4	0.02113	0.01486	0.01181	0.00535
INTCP	1	0.03963	0.06361	0.07992	0.01136
	2	0.05276	0.08826	0.06247	0.03587
	3	0.02879	0.09752	0.06570	0.02963
	4	0.03359	0.05647	0.04723	0.01646

All image files are in a one byte per pixel, binary format with pixel values scaled from 0 to 255. In programs such as L2MULT, the user may decide the water radiance scaling by setting the radiance limits using the WATER parameter, but the defaults are 0 to 2.55 mw/(steradian-micron-cm²). The water, aerosol and 443 Rayleigh radiances are all linear functions of gray level. The water radiance values are adjustable because some scenes may have features with radiances greater than 2.55. Aerosol radiance is scaled for values 0 to 2.55. Rayleigh radiance is scaled according to the minimum and maximum values for the scene and, therefore, its scaling varies from scene to scene.

For pigment concentrations (mg/m³), SEAPAK calculates the gray level values using the NET's scaling convention:

```

if (PIGMENT ≤ 1.0) then
  GRAY_LEVEL = nint( 98.38*log10(PIGMENT) + 136.0 )
else
  GRAY_LEVEL = nint( 74.17*log10(PIGMENT) + 136.0 )
end if

```

("Nint" is a function to round to the nearest integer.) The global processing pigment products are generated using the University of Miami DSP system's scaling conversion for pigment (mg/m³) which is defined as

$$\text{GRAY_LEVEL} = \text{nint}((\log_{10}(\text{PIGMENT}) + 1.4)/0.012)$$

with gray scale limits of 2 through 245 (or 1.5 to 245.49 before rounding, corresponding to pigment values of 0.0415 to 35.15).

Acknowledgements: The tables used by SEAPAK for the Rayleigh scattering computations were contributed by Howard R. Gordon, James W. Brown, and Robert H. Evans of the University of Miami. Values for Tables 1 and 2 presented here are from Robert H. Evans.

PROJECTING MULTIPLE IMAGES TO A COMMON MAP

The projection of images to a common map is often required in image analysis when studying a set of associated images. The study of a time series of images over a certain general region (Case 1) or the use of a number of images to form a single composite image covering a wider geographical area (Case 2) are two occasions where such projection is required. In both cases the images are projected to a common imaginary map and the images may or may not actually overlap with each other in geographical area. This section will describe how the projection program MAPIMG may be used to perform projection of multiple images for these two cases.

When the navigation information associated with an image is incorrect, the geocoordinates (as obtained by the program LATLON, for example) of image landmarks will also not be correct. Such images may be corrected using the program REGIST which will simply shift the gray level values relative to their pixel/line (TV) coordinates. (A monitor display of 512 pixels by 512 lines is assumed in this discussion.) This correction may be done independently of the use of MAPIMG which will map the corrected or uncorrected image using the same navigation information. Navigation data for CZCS scenes are usually accurate to within three pixels.

When using MAPIMG it is useful to think of the display (monitor) as a window or view area over an imaginary map of the world. A mapped image output by MAPIMG will normally have a portion or all of the area of the input image visible within this window. For Case 1, output images are often partially outside the window (lost) since each image in the series of images is likely to cover the earth area of interest to a different extent. Therefore the map of the world being considered is often much larger than the window for Case 1. For Case 2 however, output images are likely to be entirely within the window which will cover a large portion of, if not the entire, map. Case 2 output images can also be thought of as various pieces of a map puzzle (or mosaic) which may or may not be completely filled in.

"Output image" as used here refers to the input image as it would appear on the world map. The actual image created by MAPIMG, and contained in the file OUTFILE, is that of the window area of the map which may or may not include all of this "output image." If part of the output image is outside the window, it will be lost (i.e. not included in OUTFILE). Conversely, window pixels that are not within the output image boundary will be black (and stored in OUTFILE as such).

Controlling the Projection Characteristics of the Output

The MAPIMG input parameter PROJECTN determines the projection of the output image as well as of the imaginary map of the world of which it is a part. Although the image is projected onto that map,

the input parameters LL_1, LL_2, PIXEL, LINE, and DELTA_P allow the user to control where the window will be positioned over the map as well as the scale of the map. If defaulted, these parameters will be set such that the window will be directly over the output image area of the map and the map's scale will be such that this image will take up as much of the window as possible while remaining entirely within it. These default values are optimal for cases where images are being studied individually instead of as a group. Since these five parameters are used in conjunction with each other, if any one of them is defaulted, they will all be defaulted regardless of any values entered for some.

If no defaults are used, the PIXEL and LINE parameters refer to the TV coordinates of a point on the window whereas LL_1 refers to the geocoordinates (latitude and longitude) of a point on the world map. The points will be associated so that the window point overlays the map point. For a Case 1 study, the user may find it convenient to choose LL_1 to be in the center of the earth region of interest and assign it PIXEL/LINE values of 256/256, the center of the display (window). Alternatively, the user may wish that a certain landmark appear at a certain location on the display. In such a case, the landmark's geocoordinates would be entered for LL_1 and the desired display location specified by PIXEL/LINE. Similarly for Case 2, the geocoordinates of the geographical center of the desired composite image may be entered for LL_1 and 256/256 for PIXEL/LINE.

The use of parameters LL_2 and DELTA_P in conjunction with LL_1, PIXEL, and LINE controls the scale of the map and, hence, also controls how much of the mapped image appears on the display (i.e., within the window). LL_2 represents the geocoordinates of another point on the world map and DELTA_P represents the separation in pixels between that point and the PIXEL/LINE window location. A positive DELTA_P represents a horizontal separation, whereas a negative value represents a vertical separation.

Note that this second point need not be within the window and that the absolute value of DELTA_P may be larger than the display width or height (512 pixels or lines). For given parameters, a larger absolute DELTA_P will decrease the geographical area covered by the window (enlarge the map); a smaller absolute value will increase this area (contract the map). The direction of the second point relative to the first--that is, where they both fall on the world map--is determined solely by the projection.

Although DELTA_P represents the separation in either the horizontal or vertical direction (not the absolute separation), the points for LL_1 and LL_2 must be chosen such that they have both a horizontal AND vertical separation on the imaginary map. Therefore some a priori knowledge of where these points will fall on that map is required when choosing these parameter values.

A convenient way to determine values for LL_2 and DELTA_P is to use the geocoordinates of another landmark for LL_2 and enter the desired separation between LL_1 and LL_2 for DELTA_P. Another convenient way to determine these values is to determine the scale for the map at LL_1. (In certain cases, depending on the projec-

2 PROJECTING IMAGES

tion, the scale will vary greatly even within the window area.) That is, the user decides how many display pixels (DELTA_P) should separate a longitudinal or latitudinal degree, minute, or second and assign LL_2 and DELTA_P accordingly. For example, if the scale at LL_1 is to be one latitudinal degree per 100 pixels and LL_1 is 10 degrees latitude and 38 degrees longitude, LL_2 would be 9 and 38 degrees and DELTA_P would be -100 (assuming that north is on top for this projection).

When being run interactively and the parameter DYNNAME is the null value ("--"), MAPIMG will prompt the user for dynamic parameters soon after it has been initiated. Which parameters are requested depends on the projection that was specified.

It is important to understand that the default values for these dynamic parameters are calculated on the basis of the input image since the geographical characteristics for the map within the window have not been determined at this point. (These parameters are themselves used in the projection calculations and so, what the map would look like cannot be known at this point.) For example, if PROJECTN is 1 (UTM projection), the value for ZONE will be the number of the UTM zone in which is located the longitudinal midpoint of the input image. This ZONE value may be different from that desired for the common map onto which a series of images are being projection as described in the following paragraphs.

The dynamic parameter default values are meant to serve as a best guess for the map area that appears within the window area assuming that LL_1, LL_2, PIXEL, LINE, and DELTA_P are defaulted. Therefore it is up to the user to set these values so that they correspond to the desired map region within the window. For example, if the midpoint of this region is used for the zone in a UTM projection, this region will be at the center of a UTM-projected (imaginary) world map; if a point to the west of this region is used to determine this zone, the region will be on the right side of such a map.

When the map area within the window is large relative to the output image, as is often true for Case 2 studies, it is important to visualize this map area when deciding these dynamic parameter values. For instance, if an entire Van der Grinten (PROJECTN=19) world map will be within the window, the user may choose the central meridian such that the center of the map features the Americas, Europe/Africa, or the Atlantic or Pacific Oceans.

The input parameter ASPECT enables the user to modify the aspect ratio of the world map by stretching or contracting the horizontal and vertical aspects independently of each other. ASPECT is applied after the projection characteristics are determined by the program and so is independent of all other parameters. Since ASPECT may change the technical characteristics of a projection (a Van der Grinten projection, for example, will no longer be a Van der Grinten projection if ASPECT is not 1), a value other than 1 (the default) should only be used for special purposes such as to allow room on the display area for a caption, for example, or to permit a split screen display of more than one image.

Once the input parameters PROJECTN, LL_1, LL_2, PIXEL, LINE, DELTA_P, and ASPECT and the dynamic parameters have been established for one image, the same values must be used for the other input images in the set. This applies for both, Case 1 and 2, studies. These parameters determine the characteristics of the world map onto which the input images will be projected as well as the view area of the window.

Executing MAPIMG in Batch Mode

Because MAPIMG may be run numerous times for a given study requiring several minutes for each execution, the program has been designed to enable batch execution even though it requires dynamic parameters. The input parameter DYNNAME determines which dynamic parameter values are used during a batch execution. If DYNNAME is the null value and MAPIMG is run in batch mode, the default values calculated for the dynamic parameters and which would have been displayed on the dynamic tutor screen, will be used automatically.

To run in batch mode with non-default values for the dynamic parameters, the user must first save these values in a parameter file and enter this file name for DYNNAME. MAPIMG would first be run interactively with the null value for DYNNAME until the dynamic parameters' prompt or tutor screen is obtained. At this point the user can enter the desired values and save them into a parameter file with the SAVE command before continuing with the program or terminating it with the EXIT command. When the parameter file name is entered as the value of DYNNAME in subsequent batch runs (instead of the default null value), MAPIMG will automatically obtain the required values from the specified parameter file. Of course, PROJECTN must be the same so that the parameters saved in the file match those required during the batch execution.

Note that when DYNNAME is set to a parameter file name in interactive execution, MAPIMG will also automatically access this file for the required values without prompting or tutoring the user for the dynamic parameters. A more complete discussion of interactive and batch executions, the use of parameter files, and TAE commands is given in a separate discussion of TAE elsewhere in this manual.

Using Multiple Input Files

Although MAPIMG allows multiple image files as input (INFILE may represent seven files), these must be geographically identical such as the images of different bands of the same scene. MAPIMG will use the navigation information from the first file and apply it to all the others. If these images are not geographically identical, only the first one will be mapped correctly. As an obvious example, if the first image is of Florida while the others are of Japan, the geocoordinates of points in the Japan images (as determined by LATLON, for example) will correspond to those of the

Florida image. Therefore, MAPIMG must be run separately for each scene in a Case 1 or 2 study.

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SEAPAK User's Guide Version 2.0

Volume I--System Description

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James K. Firestone, Gary Fu, Eueng-nan Yeh,
and Daniel L. Endres**

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**SEAPAK User's Guide
Version 2.0**

Volume I--System Description

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**Sections of this User's Guide may
be revised periodically to reflect
updates to the software.**

FOREWORD

Over two years have passed since the publication of the SEAPAK Users Guide Version 1.0 (McClain et al., 1989). In that time, significant revisions to the CZCS and AVHRR support and statistical analysis programs have been made and the ancillary environmental data analysis module has been greatly expanded (Darzi et al., 1989; Firestone et al., 1990; Fu et al., 1990; Darzi et al., 1991; Firestone et al., 1991). SEAPAK now has about 200 procedures in the menu. The package continues to emphasize user-friendliness and user-interactive data analyses. In addition, because the scientific goals of the ocean color research being conducted have shifted to larger space and time scales, batch processing capabilities for both satellite and ancillary environmental data analyses have been enhanced, thus allowing large quantities of data to be ingested and analyzed in background (McClain et al., 1990).

The continued development of SEAPAK has been paralleled by three other activities that have influenced and assisted its growth. These are the global CZCS processing effort at NASA/Goddard Space Flight Center (GSFC), the collection of oceanographic datasets at the NASA Climate Data System (NCDS) at GSFC and the development of PC-SEAPAK. The global CZCS processing effort (Esaias et al., 1986; Feldman et al., 1989) was completed in March, 1990, and was a collaborative effort between Codes 936 and 971 at GSFC and the University of Miami. The quality control of the level-2 products was conducted by the ocean color investigators in Code 971 using the Oceans Computer Facility (OCF). Code 936 handled the routine ingest, processing, archival and distribution of the data. Investigators at the University of Miami Rosenstiel School for Marine and Atmospheric Sciences provided the processing software and the instrument calibration. SEAPAK incorporates the final instrument calibration and supports all levels of data available from the CZCS archive.

For the past four years, oceanographers at GSFC have been collaborating with NCDS to develop a comprehensive set of meteorological and hydrographic data. The strategy has been to coordinate their data requirements and consolidate the data collection at NCDS. This approach eliminates redundancy and provides a single source of data. Under this activity, over 30 major datasets from a number of national and foreign sources have been received, ingested, cataloged, inventoried and converted to the Common Data Format (CDF). Segments of each of these datasets have been copied in CDF form to the OCF where they are kept on optical and 8mm tape media. SEAPAK's ancillary environmental data analysis module can access all of these datasets, as well as a number of others, directly from optical or hard disk and process the data in the batch mode as well as in the user-interactive mode.

In late 1987, NASA/HQ requested a study be conducted to investigate the possibility of porting SEAPAK to a low-cost alternative configuration that emulated the original DEC VAX-based

version. The result is PC-SEAPAK. Versions 1 and 2 were released during 1989 to over 30 investigators. In September 1990, Version 3 (McClain et al., 1990a) was provided to the Computer Software Management and Information Center (COSMIC) at the University of Georgia for future distribution. Version 3 has nearly 100 procedures in the menu and is over 25MB in size. Version 4 will be released in 1991. The development of PC-SEAPAK has lead to many enhancements of the VAX-based SEAPAK software.

Finally, the next major development activity with SEAPAK will be to port it to a UNIX-based system where the hardware dependent components of the code will be replaced with software analogs. With the SeaWiFS project underway, SEAPAK's interoperability with the University of Miami's DSP will be expanded with many basic functions and formats being standardized. SEAPAK already has a close coupling to the General Meteorological Package (GEMPAK, desJardins et al., 1990) developed by the Severe Storms Branch at GSFC. Many procedures within the environmental data analysis module call routines from GEMPAK and the link between the two packages will be augmented and streamlined in the future.

The authors wish to thank the program managers at NASA HQ, past and present, who have provided support for the development of SEAPAK, namely Dr. Stan Wilson, Dr. Wayne Esaias, Dr. Curt Davis, Dr. Jim Yoder, Dr. Marlon Lewis and Dr. Greg Mitchell.

April 15, 1991
Charles R. McClain

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VOLUME II

DESCRIPTIONS OF PROGRAMS

INTRODUCTION

INTRODUCTION

SEAPAK is a user-interactive satellite data analysis package that has been developed at NASA/Goddard Space Flight Center (GSFC). Its primary applications are for the processing and interpretation of Nimbus-7/Coastal Zone Color Scanner (CZCS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR) data. It is similar in many respects to other analysis packages developed at NASA/GSFC such as the Landsat Analysis System (LAS) and the General Meteorological Package (GEMPAK) which employ the same hardware and user interface. As with all software packages, it constantly evolves as new capabilities and refinements are added. SEAPAK has not been developed for the sake of producing a large general analysis package and has never been supported as such. It is the product of the research programs of some of the scientists within the Laboratory for Hydrospheric Processes as supported by NASA/Headquarters. Its design and implementation is based on the conviction that all applications software developed should be available for use in a standardized format which provides flexibility and allows the user to truly work with the data. The system described in this document is SEAPAK as it exists in the NASA/GSFC Oceans Computer Facility (OCF). The structure of this manual is designed to be updated periodically, so sections are numbered independently of other sections and the manual is in a loose-leaf form. The manual includes sections which describe in some detail the various hardware and software components of the OCF relevant to SEAPAK, a number of data processing scenarios, an explanation of the SEAPAK menu and the programs it contains, a reference section containing detailed descriptions of all the SEAPAK programs, references and a glossary.

The CZCS was the first spaceborne sensor designed specifically to measure the concentration of photosynthetic pigments and their degradation products in the ocean. It had six co-registered bands (5 visible and one in the thermal IR) with a swath and resolution (2200 km and 825 meters at nadir, respectively) similar to the NOAA AVHRR. The CZCS IR band did not work after about the first year and was only useful for thermal feature delineation when it did work. The derived products generated by the CZCS level 2 programs are upwelled water radiance at 443, 520 and 550 nm, aerosol radiance at 670 nm, pigment concentration and Rayleigh radiance at 443 nm. A variety of programs have been developed which allow the user to derive and evaluate the input parameters required by the level-2 generation programs.

Since sea surface temperature (SST) is an important oceanographic parameter, a capability for handling SST fields from the AVHRR was developed. Many of the analysis tools developed for the CZCS derived product fields are also useful in analyzing SST fields. The algorithm for calculating the SST values from the AVHRR brightness temperatures varies depending on the satellite (TIROS-N or NOAA-6, 7, 8, 9, 10, 11). SEAPAK supports most of the

SST algorithms that have been published for different satellites. In addition, SEAPAK also allows the user to enter coefficients for a generalized SST equation.

The SEAPAK code has been developed in Fortran-77 for the Digital Equipment Corporation VAX line of CPU's and uses the International Imaging Systems (IIS) Model 75 (512x512 pixel display) as the display system with the IIS System 575 software. Some applications programs do call subroutines from the IMSL library of statistical functions which is licensed on the OCF. The user interface is the Transportable Applications Executive (TAE) which has also been developed by NASA and is written in the C language. The interface is menu driven with on-line help on all programs and input parameters.

SEAPAK is organized into several categories of programs in the menu which include tape ingest, CZCS level-2 analyses, statistical analyses, data extraction, mapping to standard projections, IIS graphics plane manipulation, IIS refresh memory manipulation, general utilities, University of Miami DSP file format conversions and ancillary environmental data analyses. Some of the Miami DSP file format conversion programs call DSP subroutines which are resident on the OCF by arrangement with the group at the University of Miami who have developed and maintain it. Most programs allow user interaction not only through the TAE menu, command and tutor modes, but also allow the user to work within a program by using the IIS trackball cursor to define pixels or areas of interest and the IIS keypad from which subprocesses may be executed in any order and any number of times without exiting the main program. Hardcopy support includes a Matrix model 4007 camera and DICOMED tape output for image data, a Hewlett Packard 7550A plotter for line plots and a system line printer for listings. Most programs also provide for ASCII file generation for further analysis in spreadsheets, graphics packages, etc.

The ancillary environmental analysis module includes support for meteorological and hydrographic data. These data may be gridded fields or random station data. The gridded fields are in the Common Data Format (CDF) developed by the National Space Science Data Center (NSSDC). Random station data such as CTD or hydrocast data is indexed and placed in master data files which may be queried by space, time, depth and parameter. The analysis of meteorological data is facilitated by utilizing GEMPAK. GEMPAK is maintained on the OCF by the scientists in the GSFC Severe Storms Branch who developed it. GEMPAK can be accessed either directly through the menu system or indirectly by using SEAPAK programs which call GEMPAK and GEMPLT subroutines.

Finally, SEAPAK has been ported to a personal computer-based image analysis system called PC-SEAPAK with support provided by NASA/Headquarters (McClain et al., 1990a). The purpose of this activity is to develop a low-cost system which emulates the VAX/IIS SEAPAK image analysis system. The hardware for this system can be easily acquired from commercial sources and PC-SEAPAK is available from NASA. This system does incorporate and even enhance the user friendliness, flexibility and versatility of the VAX/IIS system.

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For more information, contact Dr. Charles R. McClain, Code 971, NASA/GSFC, Greenbelt, MD 20771, or call at 301-286-5377.

Obtaining CZCS Data: The following types of CZCS data may be obtained from the CZCS archive at NASA/GSFC (Feldman et al., 1989):

- Level 1 Full resolution, swath projection (unmapped), calibrated radiance data for all six CZCS bands in a single scene.
- Level 1b Subsampled (every fourth pixel and line) level-1 data for bands 1 to 5; about 4km resolution.
- Level 2 Derived geophysical parameters for a single, unmapped CZCS scene at 4km resolution.
- Level 3 Level-2 composited, Earth-gridded (binned) data.

Format options for these products are summarized in Table 1.

In order to evaluate CZCS coverage, a browse capability has been developed which includes (1) software that allows the user to query a data base using a number of parameters including latitude and longitude ranges and time interval to determine the scenes available which satisfy the query criteria and (2) a set of 3 Panasonic video disks which contain all the CZCS pigment images. The browse software can be used with or without the Panasonic player and versions are available for a variety of machines including VAX and PC-AT compatibles. The advantage of using the Panasonic video player is that each image that satisfies the query is displayed and the user has the option of ordering the displayed scene before progressing to the next scene.

Orders to the archive can be initiated from within the browse session provided the system is a SPAN node. Data requests may also be filed through OMNET. Comments regarding format specification and requirements should be included with any request. For information about the CZCS archive, contact Gene Feldman, Code 636, NASA/GSFC, Greenbelt, MD 20771 (tel., 301-286-9428; OMNET, G.FELDMAN; SPAN, MANONO::GENE). The browse package is available at no charge.

Obtaining AVHRR Data: To obtain NOAA AVHRR level-1b data, contact Will Gould, Room 100, NOAA/Satellite Data Service Division, Princeton Executive Center, Washington, DC 20233 (tel., 202-763-8400). Also, one should refer to Brown et al. (1985), Kidwell (1988), and Planet (1988) regarding AVHRR data formats and calibration.

Table 1. Data formats available for 9-track and 8mm tapes.

<u>Format</u>	<u>Data</u>	<u>Procedure to Create Tape under VAX/VMS</u>
CRT	Level 1	Special program
VAX backup	Levels 1,1b,2,3	BACKUP command
Archive foreign	Levels 1,1b,2,3	MOUNT/FOREIGN and COPY
Archive labeled	Levels 1,1b,2,3	MOUNT/LABEL and COPY

SYSTEM ENVIRONMENT

- A. Hardware**
- B. Software**
- C. Optical Drive and Juke Manager**

SYSTEM ENVIRONMENT: HARDWARE

SYSTEM CONFIGURATION

The general configuration of the Laboratory for Hydrospheric Processes' Oceans Computer Facility (OCF) is shown in Figure 1. There are four CPUs which are connected via a Local Area VAX Cluster (LAVC). The LAVC utilizes the local DECNET network to effect the clustering and a DECNET interface board is installed on each CPU. DECNET is a specific network protocol which uses the Ethernet lines. Other protocols are supported on the Ethernet system such as TCP/IP, but require special interface hardware as well and are not supported on the OCF. The CPUs are one VAX 11/750 (node name OCEAN1) and three MicroVAX-IIs (node names OCEAN2, DIATOM and URCHIN). OCEAN1 serves as the central component of the cluster in that the two IIS Model 75s, the IIS IVAS, all 9-track tape drives and the 8-mm tape drive are connected to it. The 9-track and 8-mm tape drives can only be accessed through OCEAN1. All IIS image workstations are dual-ported to OCEAN1 and to one of the MicroVAXs. The MicroVAXs serve as the principal CPUs for image analysis while the VAX 11/750 serves as a backup whenever a MicroVAX is not available for use. The reason for this is that routine tape and batch operations severely impede the response of the CPU and, therefore, can greatly decrease the efficiency of users working interactively on the image workstations. For this reason, users are encouraged to execute CPU-intensive jobs in batch at night or on OCEAN1. SEAPAK is available on all CPUs and access requires that a symbol be defined in the user's LOGIN.COM file.

The LAVC also provides for access to all disk drives on the system from any of the CPUs. Some disk drives are connected directly to certain CPUs, but some are not. For instance, the four CDC SCSI disk drives are directly connected to DIATOM and URCHIN only, but may still be accessed from OCEAN1 and OCEAN2 via the LAVC. This difference is transparent to the user and is manifested only by a somewhat slower data transfer rate. In addition to the respective system drives, the only drives not available to all CPUs are the SONY optical disk drives which is dedicated to DIATOM. This is because the controller can only support two CPUs and also because the driver for the optical drives is imbedded in the University of Miami DSP system which uses DIATOM almost exclusively (some functions run on OCEAN1). Note that the Adage image display system is also connected only to DIATOM for the same reasons.

VMS has four categories of disk file operation privilege which are read, write, execute and delete, each of which is determined by the class the user is in (user, group, world, system). This is possible because each file has an owner (user) attached to it and users can be organized into groups such as "color" which contains all users associated with the ocean color investigators. Therefore, access and manipulation of files depends on the operation one wants to perform, the privileges defined for the

particular disk file and the group (if any) definition. Also, each disk will have user accounts with space quotas defined which determine whether or not a user can create files on the disk under his user ID. Only the system manager has SYSTEM privileges and is the only individual who can actually create accounts and quotas on the CPUs and the disk drives.

The OCF has been designed to accommodate group-dedicated hardware systems which allow for any group of users who have obtained funding for hardware to integrate hardware into the system yet maintain control of its use. The privilege to add hardware is overseen by the OCF Users Committee and the system manager. The committee and the system manager work together to ensure that proposed additions to the system have no adverse effects on the system and that the hardware is compatible with the existing system. They also offer advice on hardware selection. This arrangement is unusual but necessary because it is essential that certain resources such as tape drives be available to everyone, but, at the same time, research programs funded for specific tasks should be able to execute their research with minimal interference from other users. The typical arrangement is that other users may use certain group-specific hardware such as workstations on a non-interference basis. An example is the ocean color hardware which includes URCHIN, DIATOM, the SI disk drives, the CDC SCSI disk drives, the SONY optical drives, the Adage display system, the HP plotter and one of the IIS Model 75 display systems. The color investigators determine the allocation of accounts on these MicroVAXs and on these disk drives, but allow other users access to the display systems whenever they are not being used.

SEAPAK uses only the IIS Model 75s as its image display systems. These are identified in the SEAPAK software as ATLANTIC, owned by the ocean color group, and PACIFIC which is owned by the Laboratory for Hydrospheric Processes. Since PACIFIC is available to all users, time on it is scheduled although users can work on it anytime the scheduled user is not using it. ATLANTIC is not scheduled.

Hardcopy of SEAPAK data products is supported with the Matrix camera which is connected to the monitors cabled to ATLANTIC and PACIFIC. The Model 75s are actually located in the main computer room. The Matrix and the monitors are coupled through a main switch box next to the camera. The Matrix accommodates 8x10 color polaroids and transparencies and 35mm prints and slides. The format of the Matrix is controlled using the buttons on the front panel which allows the user to select the number of frames to be exposed on each shot. SEAPAK also supports DICOMED tape generation using the DICOMED program in the SEAPAK menu. Numerous SEAPAK programs support output to the HP plotter. The plotter is configured on OCEAN1 as a queued device meaning that jobs are stacked in a sequence and sent to the plotter as it finishes the current job or as it becomes available.

Maintenance and support of all the OCF equipment is provided by NASA/Headquarters under an RTOP grant to the Chairman of the OCF Users Committee. The Chairman position is rotated annually among

2 SYSTEM ENVIRONMENT: HARDWARE

the scientists in the Laboratory for Hydrospheric Processes. Each year the committee and the system manager prepare a budget for maintenance and any hardware users feel are needed. Hardware requests are identified with the particular individual or group proposing the purchase. Some hardware requests are from the committee/system manager for the use by all users or for upgrading or replacing existing equipment. NASA/Headquarters reviews the proposals and determines what will be supported.

THE IIS MODEL 75

SEAPAK runs with an International Imaging Systems (IIS) Model 75 (M75) Image Processor (International Imaging Systems, 1983) for image display and for many of its image processing functions. There are two identical M75 processors in the OCF which have the same features as described below.

Display: The display size is 512x512 pixels by 8 bits per pixel. The display monitor used is a Mitsubishi monitor. The display is 60 Hz, interlaced.

Refresh Memory: There are sixteen refresh memory channels each containing 512x512 pixels by 8 bits per pixel. Two refresh memory channels are packaged on a single printed circuit board. Thus, there are eight "channel-pairs" corresponding to the sixteen refresh memory channels. The eighth (or the graphics) "channel-pair" is reserved for the graphics data. An independent scroll feature and an independent replicative zoom feature are provided for each channel-pair. The two channels in a channel-pair is better understood by thinking of one as the foreground channel and the other as the background channel. The foreground channel and the background channel are mutually exclusive as far as the video data stream output is concerned; i.e., only the foreground channel can be used. Switching between the foreground channel and the background channel can be achieved through the scroll feature. However, the scroll, the zoom and the look-up table (described below) functions which apply to the foreground channel also affect the background channel. For example, if the foreground image is pseudo-colored with certain look-up tables, the same color scheme remains when the display is switched to the background image. As a matter of fact, a channel-pair can be thought of as a 1024x512x8 bit image memory. By use of the scroll feature, any contiguous 512x512 subsection from this 1024x512 scene may be configured for display.

Due to this channel-pair configuration, certain SEAPAK functions prohibit the use of the channels from the same channel-pair as mentioned in the program description sections. The channels in SEAPAK are numbered 1 to 14 for image data and the other two are reserved for graphics data. Channels are paired as follows: 1-8 (Channels 1 and 8 are a pair), 2-9, 3-10, 4-11, 5-12, 6-13 and 7-14.

Input Function Memory: The input function memory (IFM) is a programmable look-up table that is applied to the data on its way to the refresh memory. By use of the IFM, image data of magnitude up to 12 bits can be transformed to numbers of eight bits or less. The IFM may be bypassed so as to have no effect.

Pipeline: Three parallel pipelines are provided to perform array arithmetic for each of the three primary colors, red, green and blue (RGB). Any refresh memory channel-pair or combination of refresh memory channel-pairs can be assigned to any of the three pipelines, which, in turn, supply the RGB primary color outputs to the display. Each pipeline contains hardware split screen, eight independent look-up tables (one for each of the refresh memory channel pair), an adder array, minimum-maximum, range and constant function, and an output function memory.

The pipelines provide basic arithmetic capabilities such as addition, subtraction, multiplication, division, logarithms and exponentiation at the 30 times per second per operation rate between the 512x512 pixel arrays stored in the refresh memory or memories. The basic arithmetic is performed among displayed images with display units (or so called gray levels); no real number operations can be performed.

Look-Up Tables: Eight 1024x12-bit look-up tables (LUTs) are provided in each pipeline, one for each refresh memory channel-pair. A total of 24 LUTs exist in the M75, eight for each of the red, green and blue colors. Twelve-bit numbers are stored in the LUTs to provide better dynamic range for multiply and divide functions. The output data stream from each LUT can be selectively enabled/disabled; hence complete combinatorial flexibility is provided in assigning image bands to primary colors. For example, pseudo-coloring a single band image is done by enabling the red, green and blue LUTs of a particular refresh memory channel-pair where the single band image resides. On the other hand, true coloring (or false-coloring) of a three band image is done by enabling the red LUT, the green LUT and the blue LUT from three different refresh memory channel-pairs. The latter is an example of how loading images into refresh memories should be done with caution because the three bands of the image should be loaded into different "channel-pairs," else the true coloring can not be performed.

Each of the 1024x12-bit LUTs can be considered as four separate 256x12-bit LUTs. Eight bits on input to the LUTs are supplied by the refresh memory channel-pairs while the other two are supplied by the regions of interest (ROI or "blotched" area) stored in the graphics memory. Thus, LUT operations on the ROIs can be performed.

Adder Array: This array takes the two's complement sum of the LUT outputs. Subtraction (and division via logarithm) can be accomplished due to the two's complement sum feature. Each pipeline contains an adder array.

4 SYSTEM ENVIRONMENT: HARDWARE

Output Function Memory: Each pipeline contains an output function memory (OFM) which transforms the outputs of the range registers (described below) to generate the final red, green and blue data stream. Each OFM consists of a 10-bit in, 12-bit out look-up table. Twelve bits of resolution at the output is required for the feedback function.

Min-Max Registers: The min-max registers examine the 12-bit data stream as it merges from the adder array and determines the dynamic range of the data by finding the minimum and maximum pixel values within the 512x512-pixel array. The min-max values are used in determining the setting of the range registers (described below) to process the desired 10 bits (out of the 12-bit adder array) via the OFM.

Range and Constant Registers: The range registers are used to reduce the 12-bit data stream from the adder array to 10-bit stream for application to the OFM. The range registers allow selection of 10 contiguous bits of bits 0 through 9 or bits 1 through 10 or bits 2 through 11. The constant registers provide for the addition or subtraction of a 12-bit constant from the data stream before it is applied to the range registers.

Zoom: The zoom feature allows magnification via pixel replication of the displayed image by a factor of 2, 4 or 8 around an arbitrary location within a refresh memory channel-pair. Each refresh memory channel-pair contains its own zoom control. Within a channel-pair, the X (pixel direction) and Y (line direction) zoom factors can be independently set.

Scroll: Each refresh memory channel-pair contains independent X and Y scroll capabilities. Refer to the refresh memory subsection above for more information.

Split Screen: Split screen provides the capability of splitting the display space into four equal or unequal quadrants around an arbitrary location. Each quadrant can be supplied by any area of any refresh memory channel-pair. By using split screen, roaming of a 2048x2048 pixel image (which resides in 8 refresh memory channel-pairs) with a display window of 512x512 can be performed.

Graphics: Eight 512x512x1-bit graphics planes can be provided in the M75. The eighth refresh memory channel-pair is used for the graphics data. Either channel in the graphics memory channel-pair can provide eight graphics planes. Since only one graphics memory channel can be displayed at one time, only the background channel is used in SEAPAK for graphics. Non-destructive and destructive graphics overlay is provided. The eighth graphics plane of the graphics memory channel is reserved in SEAPAK to display the button selection menu which drives the status D/A converter. A foot pedal is provided to switch the regular display which is output from the pipeline to the status (button menu) display.

Cursor: The cursor RAM is a 64x64x1-bit memory. The shape of the cursor can be defined and stored in the RAM. The color and display (on, off, blinking) of the cursor can also be programmed. The position of the cursor can be controlled by the host computer or by the trackball (described below).

Trackball: The trackball is used to control the cursor location. In addition, fifteen function buttons are provided on the trackball housing. Each function button is programmable to control program flows. When the button is pushed and an interrupt is received by the program, a "beep" sound will be generated. The trackball unit also provides four buttons to explicitly move the cursor one pixel increment in the up/down or left/right direction. There is also a "rate" selection switch which provides four rates of cursor movement relative to a single rotation of the trackball.

Graphics Color Assignment: The eight bit output from the graphics memory and the one bit output from the cursor forms a 9-bit data stream to be assigned with proper color through the graphics color assignment function memory. This memory has 512 locations of 16 bits each. The 512 locations correspond to the 9-bit data stream. The 16-bit field defines red color component (5 bits), green color component (5 bits), blue color component (5 bits) and a replace/add mode (1 bit) for the graphics overlay. That is, destructive overlay can be done with the replace mode while the non-destructive overlay can be done with the add mode.

Videometer: The videometer is a processing element that computes the histogram at the output of the pipeline. The histogram of the entire display or only blotched regions can be generated.

Feedback-Arithmetic/Logic Unit: The feedback-arithmetic/logic unit allows the retention of output from OFM of pipeline to be captured in a different refresh memory channel (via IFM if desired) in a single frame of time. In addition, two different arithmetic or logical operations can take place during the same feedback cycle. The arithmetic or logical operations can be performed in the entire display or within blotched area. During the feedback cycle, the 12-bit output from any of the three pipelines is converted to 8-bit data and stored in the destination refresh memory channel.

MISCELLANEOUS HARDWARE

Hewlett Packard 7550A Plotter: This device provides a means for obtaining high-quality multicolor hardcopy of X/Y plots and map overlays generated by certain SEAPAK programs. X/Y plots generated by programs like RLINE, VARIOG, EOFLOT, XCORR, TSERIES, HIST, MEM and TIMENV can be output. Map overlays, including contours, annotation, grids and wind vectors can be output by the program GEMPLOT. The HP 7550A device driver from GEMPAK (described in the software chapter) is used to communicate with the plotter. This

device driver translates the user's request into a series of HP-GL (Hewlett Packard Graphics Language) commands for drawing the vector graphics in the appropriate colors and plot region on whatever medium is loaded. Therefore it is necessary to have a copy of GEMPAK on your system if you plan to purchase an HP 7550A plotter for use with SEAPAK. GEMPAK can be obtained from NASA's COSMIC software library. An RS-232-C cable interface connects the HP 7550A with the VAX 11/750 host computer. Other computers which support an RS-232-C (e.g. HP 150, HP Vectra, HP 3000, HP 9000-series 200, HP 9000-series 500, Apple II Plus, Apple IIe, IBM PC-XT, IBM PC-AT) or HP-IB (e.g. HP 120/125, HP 150, HP 9000-series 500) interface could be connected to the HP 7550A as well.

The plotter supports output to five different media types: chart paper, glossy presentation paper, overhead transparency film, vellum, and double-matte polyester film, in either ANSI A (8.5x11 inches) or B (11x17 inches), or ISO A4 (210x297 mm) or A3 (297x420 mm) sizes. Four different types of carousels are available to support the use of paper pens, transparency pens, roller-ball pens, and drafting pens (refillable or disposable). The carousels can hold up to eight pens of different colors (ten are available) and/or tip thicknesses. The force and speed with which these pens will plot is fully adjustable from the HP's LED control panel. Other features which can be controlled from this panel include pen movements, viewing of the current plot, production of a "demo" plot, rotation of plot axes, number of copies to generate, and various configuration related parameters. Paper can be fed one sheet at a time or automatically through the "Auto Feed" button. Operating mode can also be set for accessing the plotter's terminal port rather than the RS-232-C port for direct access to the plotter.

The HP 7550A has been set up as a queued device on the VAX 11/750. This means that plots will be run on a first-in, first-out basis. Spooling of plots to this queue is done, transparent to the user, when HP is chosen as the output device by any SEAPAK program. Previously generated plot files can be sent to the plot queue with the system command "HLOT" followed by the HP-GL file name.

Two of the SEAPAK environmental data applications programs, TIMENV and GEMPLLOT, support the generation of "keystroke journal" files which ultimately can produce plotted output. These files, which can be started up at any time during execution of one of these programs, contain a logging of all commands typed in through the Transportable Applications Executive (TAE) interface, described in the software chapter. Another SEAPAK program, called TOHP, allows the user to "replay" the inputs of the TIMENV or GEMPLLOT run, sending the output to the HP 7550A. Typically, users will preview the output on a Tektronix-compatible terminal supported by GEMPAK, saving the keystrokes in a file as they proceed, then run TOHP to get a hardcopy of what they saw. When running TIMENV or GEMPLLOT, the user may wish to save the journal files rather than the HP-GL plot files, since the latter are much larger in size. Journaling is not supported in the other SEAPAK programs using the

plotter, since these run on the M75 and require user intervention to press program function buttons on the trackball unit's keypad.

GEMPAK/GEMPLT Supported Devices: The GEMPAK/GEMPLT meteorological graphics package used in conjunction with SEAPAK supports many terminal and hardcopy devices. The primary ones used with SEAPAK imaging and environmental data programs are the M75, Digital VT240 graphics terminal, Hewlett Packard 7550A pen plotter, Tektronix 4105A-compatible graphics terminal, Apple Macintosh, and various Tektronix 4105A emulators on personal computers. In addition, GEMPAK/GEMPLT supports these other devices: Digital VT100 retrographics terminal, Versatec plotter, Tektronix 4010/4014 (monochrome) and emulators, Bausch and Lomb pen plotter, Digital LA100 printer plotter, Digital LN03 laser printer, and QMS laser printer. A brief description of the graphics devices follows.

1. IIS Model 75 - the image related functions of this device are described earlier in this section. Before running any applications, the IIS must be "allocated" using SEAPAK's ALLOC program. For the generation of plots, GEMPAK's device driver uses the graphics channels to draw lines, arrows, text, contours, and other symbols as needed. All or specific bit planes within this channel can be cleared using SEAPAK's GRPINTL program or all 8 bit planes can be cleared with GEMPAK's GPCLEAR. Output is generally faster than for the other devices--the entire output is typically generated in one or two "chunks" on the M75 screen. To save the graphical output to disk or restore it from disk, either the SEAPAK program BPSAV (for both save and restore), or the GEMPAK programs GPSAVE (for saving) and GPREST (for restoring) can be used.

2. Digital VT240 graphics terminal - GEMPAK contains a driver to create color output on this device using the Regis graphics language. This terminal has the advantage of allowing the user to run the TAE interface and generate graphics on a single terminal. However, the graphics and alphanumeric interface are written to the same "plane." This means that all graphics which are part of a unit (i.e. map and accompanying contours) must be drawn at the same time. Switching from graphics to text mode will result in the graphics scrolling toward the top of the screen each time a carriage return is entered.

3. Hewlett Packard 7550A pen plotter - this is fully described earlier in this section.

4. Tektronix 4105A-compatible graphics terminal - like the VT240, this is a combined graphics/text terminal. However, a 4105A-compatible terminal, such as Intecolor's Color Trend 4100, Model 140, used in the Laboratory for Hydrospheric Processes can store the text and graphics as separate "windows" on the screen. This means that the interface can overlay the graphics drawn and will not destroy or alter it in any way. Although GEMPAK software will draw only eight colors to this terminal, the user can interactively

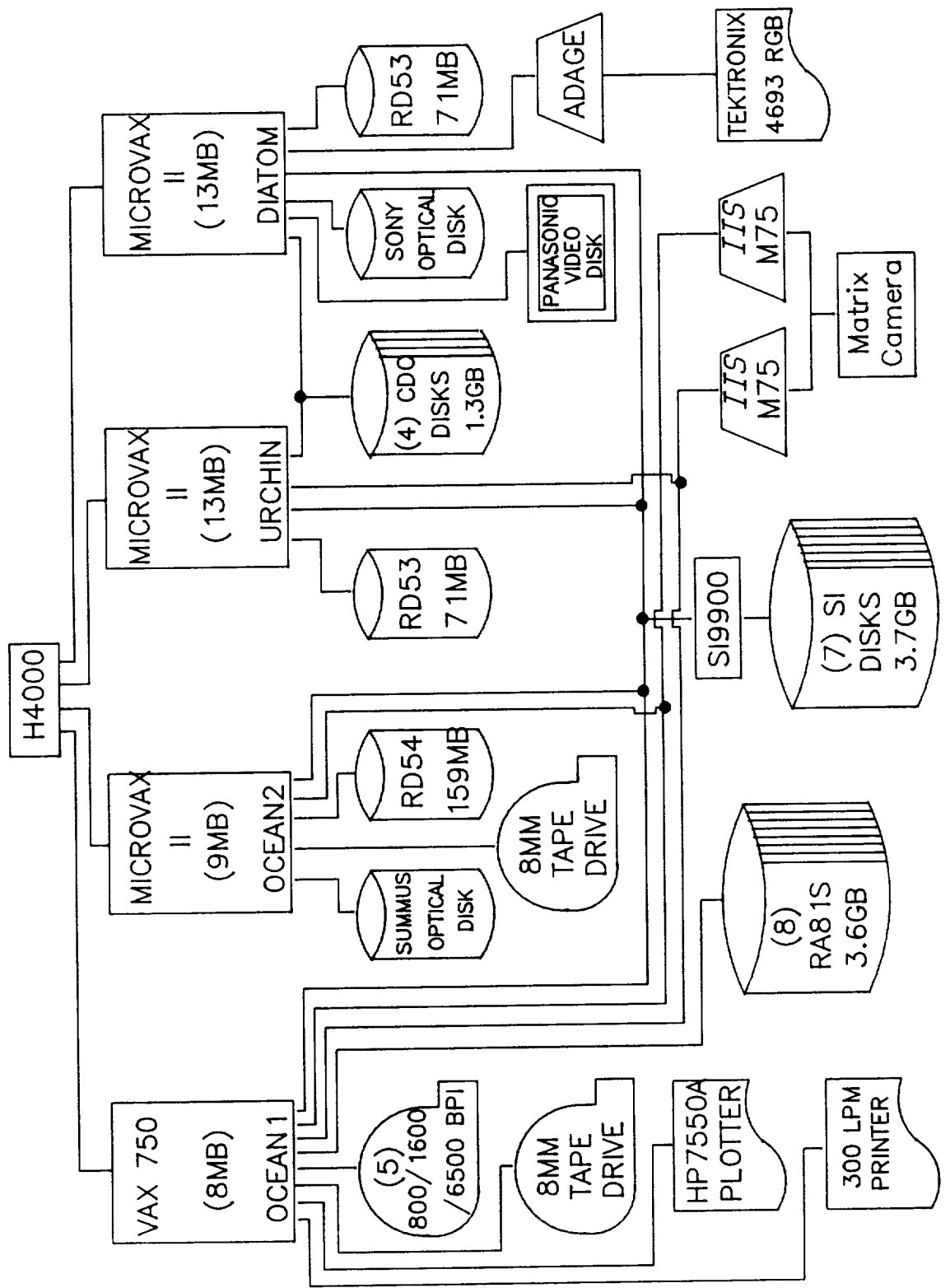
alter the colors displayed through the terminal's own hardware. Colors can be chosen from a pre-defined set or specified by their hue/lightness/saturation (HLS) components or RGB components. Up to 16 colors, taken from a palette of 64, can be displayed for the text/dialog and graphics areas. An optional mouse can be purchased as a pointing device.

The Model 140 is a 19-inch monitor with 1024x720 resolution; there is also a Model 100 which is a 14-inch monitor with 480x360 resolution similar to the original Tektronix 4105A. The Color Trends support Tektronix zoom, pan and roam, as well as Intecolor enhancements which include blink (to enhance certain colors) and flow (to simulate motion). Supported hardcopy devices include Tektronix 4695 or 4696 color copiers, monochrome copiers such as the Tektronix 4644, HP ThinkJet or Epson-type dot matrix printers, and parallel text printers having a Centronics style interface. Two alphanumeric screens and two graphics screens can be maintained. In lieu of two graphics screens, one "superscreen" can be drawn, having resolution of 700x525 (Model 100) or 1024x730 (Model 140). Roaming can be used to view any 480x360 portion of the superscreen. DEC VT100 and VT52 emulation is also included so that the terminal can be used for text editing.

5. Macintosh - GEMPAK uses a monochrome Tektronix terminal (4010/4014) emulation to create graphics on the Apple Macintosh or Macintosh II. A commercial package such as Versaterm-Pro must be installed on the Macintosh to perform this emulation. When a graphics program is run under TAE, GEMPAK will put the Macintosh in graphics mode automatically and return it to text mode when the graphics is complete. On the Macintosh, unlike the VT240, there is enough memory for the graphics to be accessible even after it is drawn. Since text and graphics do not overlay one another (e.g. appear simultaneously) as on the Color Trend, the user must manually change between text and graphics modes. This can be done easily through Versaterm Pro's interface.

6. Tektronix 4105A emulators for personal computers - these cover a broad spectrum of commercial products offering differing degrees of true 4105A emulation. Examples of emulation packages available at the OCF are Grafpoint's TGRAF-715 and Scientific Endeavors' VTEK. These perform more similarly to the original Tektronix 4105A than to the Color Trend described above. These emulators are capable of providing graphics generated by GEMPAK within SEAPAK programs at a fraction of the cost of a dedicated graphics terminal.

OCEANS COMPUTER FACILITY VAX CLUSTER



SYSTEM ENVIRONMENT: SOFTWARE

SEAPAK was written to run under the VAX/VMS operating system. In order to invoke SEAPAK the user must first execute the VMS command

```
@xxxx:[SEAPAK]LOGIN
```

(1)

where "xxxx" is the name of the disk drive on which the main SEAPAK directory resides or a VMS logical defined as that drive. This command executes the login command file of the SEAPAK account which in turn defines a number of VMS logicals and symbols (see the section on VMS below) required for the proper functioning of SEAPAK. One of these is the symbol "SEAPAK" which the user may then enter as a VMS command in order to invoke SEAPAK. For convenience, Command 1 should be included as part of a user's account login command file. This is a file consisting of DCL commands which are executed automatically whenever that account is logged onto. In this way, "SEAPAK" will be available automatically for use as a command after logging in.

SEAPAK is a collection of programs designed principally for the analysis of CZCS images. All of these programs use NASA's TAE (Transportable Applications Executive) for their user interfaces. Therefore, SEAPAK requires that TAE be installed on whatever system it is to be used. A brief discussion of relevant TAE aspects is given in a separate section below. The imaging system used by SEAPAK is the IIS Model 75 which is also discussed separately.

For the Laboratory of Hydrospheric Processes' local area VAX cluster, the main SEAPAK drive ("xxxx" in Command 1) is SIA0. As implemented on this cluster, SEAPAK may be invoked from any of the four nodes: OCEAN1, URCHIN, DIATOM, and OCEAN2. With certain exceptions, most programs may also be run from any node. Two Model 75 systems, ATLANTIC and PACIFIC, are available--ATLANTIC from OCEAN1 and URCHIN and PACIFIC from OCEAN1 and OCEAN2. Programs requiring the use of a Model 75 are, therefore, restricted to these nodes. An Adage imaging system for use with the University of Miami's image analysis system, DSP, is available from DIATOM. SEAPAK programs (e.g., DSPIMG) related to the conversion of DSP image files make use of DSP but may be run from any node. Ingest programs (e.g., TP2IMG) require 9-track tape drives and, therefore, are restricted to OCEAN1, the only node from which the tape drives are accessible. In addition, the Sony optical disk drives can only be accessed from DIATOM and the 8mm tape drive operates only from OCEAN1.

VIRTUAL MEMORY SYSTEM (VMS)

VMS is an operating system for VAX computers which uses DCL (DEC Command Language). Extensive on-line help on many of the

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topics discussed in this section may be obtained by simply entering the DCL command HELP. DCL commands may be abbreviated to the fewest letters which will not cause ambiguity with other commands. SEAPAK-specific definitions may be obtained by pressing the HELP key.

VMS Symbols: In VMS, "symbol" refers to a character string which has been defined to represent another string--usually a DCL command or a portion of one. Symbols may be defined using the "==" characters. For example,

```
ST == SHOW TIME
```

defines "ST" to be the DCL command SHOW TIME which shows the current system date and time. Symbols defined in this manner remain valid only during the session in which they are defined unless they are included in the account's login file.

SEAPAK users may enter the symbol "SPSYM" to display symbols defined for them by the SEAPAK login file (Table 1). These symbols may be redefined to represent other strings after the SEAPAK login file is executed.

VMS File Names: The names of files in VMS consist of various portions which specify the location of the file as well as its name. The string

```
OCEAN1::BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
```

Table 1. VMS symbols defined by the SEAPAK login command file for SEAPAK users on NASA/GSFC's OCF VAX cluster. Symbols containing an asterisk may be abbreviated down to the letters preceding the asterisk. (The asterisk is not part of the symbol.)

<u>Symbol</u>	<u>Definition</u>
SEAPAK	Invokes SEAPAK
CPU	Displays system's CPU usage
USE*RS	Lists users logged onto system
SI	Lists information for devices with "SI" in name
DU	Lists information for devices with "DU" in name
PAC*IFIC	Displays information for PACIFIC (IIS Model 75)
ATL*ANTIC	Displays information for ATLANTIC (IIS Model 75)
IIAO	Displays information for PACIFIC (IIS Model 75)
IIBO	Displays information for ATLANTIC (IIS Model 75)
BBQ	Displays jobs on SYS\$BATCH queue
LPQ	Displays jobs for line printer queue
HPQ	Displays jobs for HP plotter queue
W132	Sets terminal width to 132 characters
W80	Sets terminal width to 80 characters
SP	"SET PROTECTION="

Table 1. VMS symbols defined for SEAPAK users at OCF. (Cont'd)

<u>Symbol</u>	<u>Definition</u>
PU	Purges directory's files which are not most recent versions
LOGIN	Runs login command file in user's account
GEMPAK	Runs GP\$DSK00:[GEMPAK]GEMPAK.COM
HOME	Sets default to home directory from any directory
SPDEF	Displays logicals defined by SEAPAK login command file
SPLOG	Displays SEAPAK login command file
SPSYM	Displays symbols defined by SEAPAK login command file
SPTERM	Displays terminal characteristics defined by the SEAPAK command file
ASC	Lists *.ASC files in default directory with date, size
BLO	Lists *.BLO files in default directory with date, size
CTL	Lists *.CTL files in default directory with date, size
DAT	Lists *.DAT files in default directory with date, size
IMG	Lists *.IMG files in default directory with date, size
L2P	Lists *.L2P files in default directory with date, size
LIS	Lists *.LIS files in default directory with date, size
LOG	Lists *.LOG files in default directory with date, size
PAR	Lists *.PAR files in default directory with date, size
TXT	Lists *.TXT files in default directory with date, size

is an example of a valid file name. In this case, "OCEAN1" is the name of the system or node, "BIO4" is the name of the device (such as disk drive), and "MYACNT.SUBDIR" specifies the path to and the name of the directory, SUBDIR. "GOOD_DATA" is usually referred to by the compound word "filename" to indicate this specific (and main) portion of the name. Finally, "RECENT" is called the file name extension or type.

If the node, device, or directory are not specified in a file name entered as part of a DCL command, VMS assumes the current node, device, or directory by default. The DCL command SHOW DEFAULT will display the current device and directory. SEAPAK users may also press the PF1 key which will change the prompt string (up to 32 characters) to be the current node, device, and directory; pressing PF1 again returns to the default prompt.

VMS Logical Names: In VMS, a character string may be defined to represent a file name or a portion of a file name and used subsequently when specifying that file. Such strings are called logical names, or logicals, and may be defined using the DCL DEFINE command. For example, the following commands may be entered:

```
DEFINE LOG1 BIO4
DEFINE LOG2 BIO4:[MYACNT.]
DEFINE LOG3 LOG2:[SUBDIR]
DEFINE LOG4 LOG3:GOOD_DATA.RECENT
DEFINE LOG5 BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
```

These commands would render equivalent the following file name specifications:

```
BIO4:[MYACNT.SUBDIR]GOOD_DATA.RECENT
LOG1:[MYACNT.SUBDIR]GOOD_DATA.RECENT
LOG2:[SUBDIR]GOOD_DATA.RECENT
LOG3:GOOD_DATA.RECENT
LOG4
LOG5
```

Logical names can greatly reduce the amount of typing required to specify files. For example, "LOG3" above can be used as a prefix when specifying any of the files in the directory it represents. Moreover, if a logical is used as part of a name inside a file, it may be redefined to represent another directory or file name without having to modify (edit) the file.

Logicals remain valid only during the session in which they are defined unless they are included in the account's login file. SEAPAK users may enter the symbol "SPDEF" to display logicals defined for them by the SEAPAK login file. These logicals may be redefined to represent other name parts after the SEAPAK login file is executed.

File Names as SEAPAK Parameters: Many SEAPAK programs require file names as input parameters. With some exceptions, SEAPAK programs will generally supply certain parts of a file name specification by default according to the convention described here. For more specific information, the reader is referred to the descriptions or help texts of the file name parameters for each program.

If a device is not specified in a name, the logical "SCRATCH" will be used. If the device and the directory are not specified, the root (topmost or main) directory will be used along with "SCRATCH". If an extension (including the period) is not specified, an extension (as mentioned in that parameter's description) will be supplied. The following are examples of the entries for file name parameters and the actual names used assuming that the current default directory is "[MYACNT.SUBDIR]" and that the default extension is "IMG":

N_ATL	==>	SCRATCH:[MYACNT]N_ATL.IMG
[MYACNT.OCEANS]N_ATL	==>	SCRATCH:[MYACNT.OCEANS]N_ATL.IMG
BIO4:N_ATL	==>	BIO4:[MYACNT.SUBDIR]N_ATL.IMG
BIO4:N_ATL.	==>	BIO4:[MYACNT.SUBDIR]N_ATL.
BIO3:[MYACNT.OLD]N_ATL.DAT	==>	BIO3:[MYACNT.OLD]N_ATL.DAT

The reasons for this logic are as follows. Users may have space reserved on a device other than the home disk for storing certain files, especially large ones such as image or data files. This device can be assigned the logical name "SCRATCH". (This name does not imply anything about the permanency of the files.) For the same account, such an alternate device would not likely have a directory structure like that of the home device or, for that

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matter, may not have any subdirectories at all. Thus, not specifying the device and directory indicates to the program that the root directory on "SCRATCH" is to be assumed (first example). Similarly, if the directory but not the device is specified (second example), that directory is used but "SCRATCH" is assumed. However, if the device is specified but not the directory (third and fourth examples), the current default directory (a root or subdirectory) is assumed.

Users who do not have space reserved on an alternate device for this purpose may wish to redefine "SCRATCH" to be the home device after the execution of the SEAPAK login file. This would remove the need to specify the home device in each file name entry.

Conventional File Name Extensions: File name extensions are normally used to indicate the type of information stored in files while filenames are used to differentiate between files with the same extension in a given directory. Within VMS, certain extensions are reserved as defaults for files with certain types of information. This is done only for uniformity and organizational purposes and any extension may be used for any file if the extension is specified (i.e., not allowed to default). (Directory files, however, must have the extension "DIR" so as not to obtain inconsistent results with some DCL commands.)

SEAPAK and TAE also reserve certain extensions as defaults according to the type of information contained in files (Table 2). Whether reserved by VMS, SEAPAK, or TAE, these extensions prove helpful when users follow the convention of their usage.

TRANSPORTABLE APPLICATIONS EXECUTIVE (TAE)

When a user enters "SEAPAK" to invoke SEAPAK, it is the application executive TAE (Century Computing, Inc., 1985; Perkins et al., 1988) and its interface which is actually invoked. The interface has only been slightly modified to customize it for SEAPAK users. For example, the command prompt "SEAPAK>" is seen instead of the generic default prompt, "TAE>". TAE is a powerful system providing on-line help, different execution modes, automation of commands, and command syntax flexibility. Only a rudimentary description of these capabilities is given in this section; more extensive information may be found in usage manuals available from NASA/GSFC's TAE Support Office (Code 521).

Command and Menu Modes: There are two interactive methods of invoking programs in TAE, by commands or from option menus. The default method for SEAPAK is by commands--the command prompt "SEAPAK>" is displayed after the initial header page when SEAPAK is invoked. A user can switch to menu mode by entering the TCL (TAE Command Language) command "MENU" at a command prompt and switch back by entering "COMMAND" while in menu mode. (TAE distinguishes between various types of commands: TCL, menu, tutor, and program names. All of these, except program names, may be abbreviated down

Table 2. SEAPAK conventions for file name extensions.

<u>Extension</u>	<u>Code</u>	<u>File content or type</u>
ANC	ASCII	Control point file associated with full-scan CZCS image
ASC	ASCII	All or part of a SEAPAK image
BLO	Binary	IIS Model 75 graphics
CLR	ASCII	Results from SEAPAK's clear water algorithm programs
COM	ASCII	VMS DCL command file
CTL	ASCII	Control point file associated with unmapped SEAPAK image
DAT	ASC/Bin	General data file
DIR	Binary	VMS directory file
EXE	Binary	VMS executable file
FOR	ASCII	FORTTRAN source code
FUL	Binary	Full-scan SEAPAK image
HLP	ASCII	Help text for SEAPAK program
IMG	Binary	Standard SEAPAK image
L2P	ASCII	Log file from SEAPAK's level 2 programs
LST	ASCII	Tabulated data
LOG	ASCII	Output from a batch job
LUT	Binary	IIS Model 75 look-up-table definition
OBJ	Binary	Compiled program file
PAR	Binary	TAE parameter file
PDF	ASCII	TAE parameter definition files
TSL	ASCII	TAE session log

to the fewest letters needed to avoid ambiguity. None of the commands are case specific. TCL commands and program names may be entered any time at a command prompt. Commands available in menu and tutor modes are listed at the bottom of their respective terminal displays. TCL commands are those of the TAE Command Language.)

In command mode, the user may enter the TCL command "TUTOR" followed by the program name in order to obtain the tutor (or parameter) menu for that program. (TCL commands may themselves also be used with TUTOR.) This menu will display all the parameters required for running the program along with any default values. As values are entered for each parameter, the menu is updated to display the new values. When all entries are made, the program may be started with the tutor command "RUN".

An alternate way of invoking a program in command mode is to enter that program name and required parameters as a command line. For example,

CURMOD CHANNEL=5 COLOR=(RED, GREEN) (2)

will run the program CURMOD with the values specified for its parameters. The default values will be used for parameters not

listed (such as STARTPIX and ENDPIX for CURMOD in Command (2). Parameter names may be abbreviated if there is no ambiguity. The names and the equal signs may be omitted altogether if the values listed are in the order that the parameters appear on that program's tutor menu. A plus sign may be used as the last character in a line to indicate that the command continues on the following line.

In menu mode, each menu presents the user with a set of options from which to select. The options represent either programs, enclosed by parentheses, or other menus, enclosed by square brackets. If a menu option is selected, that submenu will then be displayed. If a program option is selected, the tutor menu for that program will be displayed and the user may proceed as described above. After a program is run, the same option menu will reappear.

SEAPAK programs are organized into menus with a tree structure.) (See listing of the menu tree structure in Appendix.) The user may navigate forward along the tree by selecting menu options, or backward by entering "BACK", until the desired program is given as an option on the displayed menu. Each menu represents a logical grouping of programs and submenus. (A complete tree structure of the SEAPAK menus and programs is presented elsewhere in this guide.) Inexperienced users will find the menu mode easier to use for locating and invoking the programs needed to accomplish a given task. For more experienced users, command mode provides a more rapid way to invoke any program directly.

Subcommands and Dynamic Parameters: Some SEAPAK programs (e.g., DERIV) have more than one major branches in their processing logic which are distinguished by "subcommands." (Many TCL commands also have subcommands associated with them.) The subcommand name, preceded by a dash, must be appended to the program name if entered as a command line. Tutoring on such programs will display a subcommand menu. The tutor menu for a subcommand version of the program will be displayed after a subcommand is selected. Alternately, the tutor menu for a subcommand version of the program may be obtained directly by appending the subcommand (with dash) to the program name in the TUTOR command. Subcommand names may be abbreviated.

In many cases, SEAPAK programs require values to be input for "dynamic" parameters. These are parameters whose values are required during execution of a program. Which parameters to request, if any, and their default values, if any, may need to be determined by the program based on the values of the initial input parameters. A program will then generate a prompt or tutor menu requesting the values for these parameters. (If a prompt is issued, the tutor menu may be obtained by entering "TUTOR".) After entering these values, the user may enter "RUN" to continue with the program. The parameter value list may also be entered on the same line after this RUN command in the same way that a program is invoked from command mode without tutoring. Requests for dynamic parameters may occur more than once for a given program.

Parameter Files: TAE provides a convenient way to save the values entered for a program's set of parameters. This may be done using the SAVE command while in tutor mode or at a dynamic parameter prompt to create a disk file in the default directory containing the parameter names and their values. These values may be reloaded subsequently for the same parameters with the RESTORE command or qualifier. If the parameters in a parameter file do not match those for which the values are to be restored, an error message will be issued when RESTORE is used.

The form of the SAVE command is "SAVE fname", where "fname" is the name of the parameter file. If the extension (type) is not specified in "fname", ".PAR" is assumed; if the directory (path) is not specified, the current default directory is assumed. If "fname" is omitted, the program name is used by default as the file name with the type ".PAR". Dynamic parameters are also associated with a program name, usually being the main program name with the characters "DYN" appended. This name would thus be used as the default parameter file name in a SAVE command for dynamic parameters. (All tutor menus indicate the name of the associated program at the top of the display. Dynamic parameter prompts also indicate the associated program name in the prompt string after "SEAPAK-".)

In tutor mode or at a dynamic parameter prompt, the RESTORE command also has the form "RESTORE fname" where "fname" is as described above. When this command is entered, the display will indicate the restored values.

RESTORE may also be used with a different syntax as part of a command line when invoking a program as in the following example:

```
CURMOD |RESTORE="PARSET1"| CHANNEL=3
```

(3)

In this example, "PARSET1" indicates that PARSET1.PAR is the parameter file name and that it is located in the default directory since the path is not specified. In this case, RESTORE is actually a TAE-specified parameter called a command qualifier. These qualifiers can only be listed between vertical bars on a command line. Any parameter values listed after the RESTORE qualifier on the command line (such as "CHANNEL" in Command 3 will override those in the parameter file. If an empty string (indicated by two double quotes "") is given for the RESTORE qualifier, the program name is assumed for the parameter file name.

Any time a program is invoked from a tutor menu or continued from a dynamic prompt or tutor menu, the parameter names and their values are automatically saved in the default directory in a parameter file called LAST.PAR. Thus, entering "RESTORE LAST" causes the values to be restored as they existed when "RUN" was previously entered. Obviously, this feature is very useful when running a program more than once consecutively.

Using DCL from within TAE: One of the TCL commands is "DCL" which allows the user to enter DCL commands without exiting SEAPAK (i.e., TAE). The command has the form "DCL comnd" where "comnd" is the actual DCL command including any associated qualifiers and

parameters. If "comnd" is omitted, the prompt "_\$" will be displayed, placing the user in DCL mode where DCL commands may be entered directly. To exit DCL mode and return to SEAPAK, the user can enter "EXIT" or "TAE".

"DIRECTORY" is a DCL command which, for convenience, may be entered directly as a TCL command without being preceded by "DCL". Qualifiers allowed by DCL for DIRECTORY (e.g., "/SINCE") also may be used in the same way with the TCL version of that command.

Batch Execution: A program may be submitted to the system's batch queue by setting the qualifier RUNTYPE to "BATCH". Running a program in batch allows the user to proceed with other tasks while the batch program is running or waiting to be executed. Therefore, it is very advantageous to use batch jobs for programs requiring extended time to run or for running a large number of programs. Once a program is submitted, it is no longer dependent on the current session which may terminate before the program ends or starts executing. Obviously, batch execution may not be used for programs which require interaction with the user such as by the use of a Model 75 or dynamic parameters. (Some programs, such as MAPIMG, which use dynamic parameters have been specially designed to enable batch execution. Such exceptions are noted in the descriptions of these programs.)

When the submitted program executes, a log file containing the program's output that would normally appear on the terminal along with other information will be created. The file will have the name of the program with the type ".LOG" and will be located in the main directory of the user's account. Log files include the user's login file and any command files which it invokes, such as the SEAPAK login and associated files.

The following example shows how a program may be submitted to the batch queue in TAE command mode:

```
ADDF |RES="",RUN="BATCH"| FACTOR=3
```

(4)

This command submits the program ADDF to run in batch using the parameter file ADDF.PAR in the default directory but with the value of 3 for the parameter FACTOR. (The qualifiers "RESTORE" and "RUNTYPE" have been abbreviated.) In tutor mode, the command

```
RUN |RUN="BATCH"|
```

(5)

will submit the program being tutored using the parameter values currently on the tutor menu.

The SHOW-BATCH or BATCH-STATUS commands may be used to examine the status of a batch job. The ABORT-BATCH command may be used to abort a submitted batch job. The abort command require as input to a parameter, JOBID, the entry number assigned to the batch job. This number is displayed on the terminal immediately after the job is submitted and may be examined using the status commands. For example,

SHOW-BATCH
ABORT-BATCH JOBID=906

(6)
(7)

will abort job 906 which the user would have observed as being on the queue by the SHOW-BATCH command. These and other batch-related commands also require as input the name of the batch queue in question since host systems may have more than one such queue. In most of these commands, the default value for the QUEUE parameter is the VMS logical "SYS\$BATCH"; for BATCH-STATUS, the default value for the QUEUE parameter is "ALL". The default QUEUE value is used in Commands 6 and 7.

It is very important to realize that the system environment under which a batch job will execute is the same as that which exists immediately after logging in to the system. That is, VMS logicals and symbols defined during the session in which the batch job is submitted will not be valid unless they are included in the account's login command file. This fact often leads to failed attempts by novice users of the batch capability.

One of the major advantages of running batch jobs is to delay their execution so that they are run at a time (e.g., overnight) when they will not adversely impact the system's users by consuming excessive amounts of CPU time. The DCL command SUBMIT, used to run batch jobs, allows the user to specify the time of execution among many other options for that command.

As the following pair of commands indicate, TAE provides a way for the user to take full advantage of the power of the SUBMIT command.

```
ADDF |RES="",RUN=("BATCH","NORUN")| FACTOR=3 (8)
DCL SUBMIT/AFTER=22:00/NOPRINTER/KEEP ADDF.JOB (9)
```

Command 8 instructs TAE to create the same batch job as that of Command 4 but not to run it (i.e., not to submit it to the batch queue). Command 9 tells TAE to execute the DCL command SUBMIT for the batch job file "ADDF.JOB" created by Command 8. The DCL "/AFTER" qualifier to SUBMIT indicates that the job is to be queued for processing after 10 PM. The "/NOPRINTER" and "/NOKEEP" qualifiers indicate that the log file should not be automatically printed and should be deleted from the disk, respectively; "/PRINTER" and "/KEEP" may be used to indicate otherwise. ("/PRINTER" is the default for the DCL command SUBMIT; "/NOKEEP", which deletes the disk file, is the default when "/PRINTER" is used, otherwise "/KEEP" is the default. A log file should not be automatically printed as it may be quite long. For convenience, "SUBMIT" has been defined as a symbol for SEAPAK users to represent the DCL command SUBMIT/NOPRINTER/NOTIFY. The "NOPRINTER/KEEP" qualifiers in Command 9 are not required since the no-print option is, in effect, the default).

Asynchronous Execution: When a program is run asynchronously, it will begin executing immediately while permitting the user to proceed with the session. It will continue to execute concurrently

until it terminates or the session is terminated. Asynchronous jobs are initiated from SEAPAK in the same way as batch jobs except that the RUNTYPE qualifier is set to "ASYNC". A log file is also generated as for batch jobs.

Unlike batch jobs, asynchronous jobs can request dynamic parameters. When the program reaches a point in its processing where these parameters are required, it issues a message to the user. The program is then suspended until the user responds using the REPLY command in menu or command mode. However, asynchronous execution is not allowed for programs requiring a Model 75.

The SHOW-ASYNC command may be used to examine the status of asynchronous jobs while ABORT-ASYNC may be used to abort them. Other commands related to asynchronous jobs are also available.

On-Line Help Text: Extensive on-line help text is available to the user at any point requiring user input. In command or menu mode, entering "HELP" provides a summary description of TAE commands. For more specific information, "HELP cname" can be used where "cname" is a command or program name. In menu mode "cname" may also be the number of an option on the current menu.

In tutor mode (as well as dynamic prompt mode), "HELP pname" will provide a more detailed description of the parameter "pname". If "pname" is an asterisk, a description of the tutored program will be displayed. If "pname" is omitted, general information on the tutor mode will be provided.

Other TAE Features: The TCL DEFCMD command may be used to define a string as a temporary TAE command which may be used subsequently in a given session. For example,

```
DEFCMD RUN*CURM STRING="CURMOD |RESTORE=""PARSET1""|CHANNEL=3"
(10)
```

defines "RUNCURM" to be Command 3. The asterisk indicates that the newly defined command name may be abbreviated down to "RUN" and still represent the same command. Double quotation marks occurring in the definition string must be repeated to indicate that they are part of the string.

For commands which will be repeated the same way or with slight modifications, the use of command files can prove very useful. In TAE, such files are called procedures and become essentially additional programs. Procedures consist of TCL commands and program invocation command lines. Among other capabilities, TCL allows unconditional and conditional branching, looping, and communication with programs invoked from the given procedure. Therefore, a user may create procedures which can vary greatly in complexity depending on the task to be performed as well as the user's own ability with TCL.

A log file of program invocations during a SEAPAK session may be created using the TCL command ENABLE-LOG. When this command is issued, a file called SESSION.TSL is created in the user's default directory. The command DISABLE-LOG is used to disable session logging while the command SESSLOG may be used to examine the log

file. (SESSLOG automatically enables logging if it had been disabled. When logging is enabled more than once the same log file is used.) The log file keeps a record of all program invocations, their parameters and parameter values, program termination output values, and other information.

To abort a program in progress, the user should enter "<control>C" followed by "ABORT" at the next prompt. The user should avoid entering "<control>Y" which may terminate the SEAPAK session as well as any executing program.

To end a SEAPAK session without logging off the host system, the user may enter the TCL command "EXIT" at the command prompt. This command is not available in menu mode. In tutor mode, "EXIT" will return the user to the command prompt or the previous option menu without invoking the program. At a dynamic prompt or tutor menu, "EXIT" will result in action controlled by the internal logic of the program, which usually is termination of the program. To terminate a SEAPAK session as well as log off the system, "LOGOFF" may be entered in command or menu mode.

IIS SYSTEM 575

The IIS Model 75 comes with System 575 software which contains its own user interface, data base management system, and a library of intrinsic functions (International Imaging Systems, Inc., 1984). When SEAPAK was first developed, System 575 was evaluated for its user interface and data base management capabilities and the decision was made to use only the intrinsics, including hardware-specific and hardware-independent functions, for SEAPAK development. Portions of the Model 75 software used by SEAPAK are described briefly here.

Device Handler: The Model 75 device handler package is the most basic software package. It provides the interface to the Model 75 display hardware. The device handler used by SEAPAK is specific to the VAX/VMS operating system.

Interface and Utility Routines: The interface and utility routines package consists of a collection of about 80 FORTRAN-coded subroutines. The 30 interface routines are used to control the various Model 75 hardware components (refresh memory, look-up tables, cursor, IFM, OFM, feedback unit, etc.). The utility routines provide higher level of interface to the Model 75.

Primitives Package: The primitives package consists of approximately 60 FORTRAN-coded subroutines that provide a high level of software interface to the Model 75's hardware image processing capabilities. These subroutines call the interface and utility subroutines to accomplish the image processing function utilizing the Model 75 hardware features.

GENERAL METEOROLOGICAL PACKAGE (GEMPAK/GEMPLT)

SEAPAK uses GEMPAK/GEMPLT software (desJardins et al., 1988 and 1990; desJardins and Petersen, 1989) to facilitate the computation and display of gridded oceanographic and meteorological parameters taken from a variety of data sources. Some examples of these data include global data sets of bathymetry from NORDA, winds from FGGE, FNOC or NMC, and SST's from NOAA's CAC. These data, in the form of contoured fields or wind vectors/streamlines, serve as an ancillary overlay on the CZCS or AVHRR imagery supported within SEAPAK.

GEMPAK is a large software package for meteorological data analysis, developed and maintained in the Severe Storms Branch of the Laboratory for Atmospheres, NASA/GSFC. The programs are run from either the menu or command modes of the TAE interface. There is also a FORTRAN-callable subroutine library available with GEMPAK that allows access to the component parts of the applications programs. In SEAPAK, this library is used to perform scalar and vector gridded diagnostic computations (e.g., surface stress, divergence, Ekman transport) from observed zonal and meridional wind components. Major subdivisions of the GEMPAK menu tree are devoted to analysis of surface data, upper air sounding data, gridded data, and the performing of objective analyses to place irregularly spaced observations in a gridded array. The GEMPAK package of analysis programs may be accessed directly from SEAPAK's root menu.

GEMPAK can handle both real-time (from a FAA 604 data line) or historic, conventional meteorological data. Surface programs allow the user to create binary surface datasets, insert data into this file from another binary file or an ASCII text file, and list or map data from the binary file onto any of the supported graphics devices. There is a great deal of flexibility in choosing the data and graphics regions, time periods, and characteristics of the output including colors, line types and widths, map backgrounds, contour intervals, etc. Upper air programs include drawing of vertical thermodynamic and wind profiles for specific stations, creation of a horizontal contour map by combining data for many soundings at a given level, drawing of a horizontal cross section composed of several soundings, various data listing programs, and sounding dataset manipulation programs. Gridded data set programs support horizontal maps of the data, contouring, wind barbs, arrows or streamlines, creation of vertical profiles from co-located grids, creation of diagnostic grids, and various listing and grid file manipulation programs. The objective analysis package performs a Barnes analysis of either sounding or surface data irregularly spaced, creating a grid with the latitude/longitude spacing specified by the user.

GEMPLT handles the display of output from the GEMPAK applications programs. Like GEMPAK, GEMPLT can be accessed from a TAE menu interface or a FORTRAN subroutine library. The menu portion consists of control programs, attribute programs, and plotting programs. The control programs provide for the initial setup of

GEMPLT with a specified graphics device, setting of map projections, clearing the device, and handling of plot files for hard copy devices. Attribute programs allow control over the view region for graphics on the specified device, and characteristics of the colors, markers, lines, wind indicators and maps which will comprise the output. Plotting programs can perform the drawing of grids, titles, borders, and maps, in addition to the saving and restoring of graphics to/from disk for devices having a readback capability.

SEAPAK's environmental data module, and a group of image processing programs which use the HP 7550A plotter, make extensive use of the library routines of GEMPLT. For example, using GEMPLT's map mode, program GEMPLOT can draw contours of raw or diagnostic data, grids, or wind vectors overlaying coastlines or political map boundaries in a variety of projections. The user can control where the plot is drawn on the chosen graphics device, and any of the characteristics controllable through the attribute program menu. Similar control is given within SEAPAK program TIMENV, which uses GEMPLT's graph mode to create time series X/Y plots. By using the GEMPLT subroutines in a FORTRAN program rather than using the menu interface, customized applications can be built. These applications can take advantage of hardware features and data formats not used by the menu interface. For instance, GEMPLOT and TIMENV can utilize the trackball and button interface available on the IIS Model 75 for user interaction with the software. They also support data sets in the NSSDC Common Data Format (CDF; Treinish and Gough, 1987), which provides access to a multitude of space science, oceanography and meteorology data sets stored at NASA/GSFC.

LAND ANALYSIS SYSTEM (LAS)

Another major software component accessible from SEAPAK's root menu is NASA's Land Analysis System (LAS; Science Applications Research, 1987). This is a package for manipulating and analyzing multi-spectral image data. Functions include the ingest of various sensor data types, geometric and radiometric corrections, training site selection, image registration, Fourier domain filtering, supervised and unsupervised classification, and image enhancement. As with SEAPAK and GEMPAK/GEMPLT, LAS runs under the TAE interface, allowing access to the programs through menu and command modes, with an extensive on-line help facility. An accompanying Catalog Manager package provides users with the ability to assign names for data files, and to organize the cataloged set of names in a structure suitable for the user's application.

OPTICAL DRIVE AND JUKE MANAGER

Overview: This chapter describes the methods for reading and writing optical disks using the University of Miami JUKE_MANAGER software on a Sony model WDD-3000 laser drive. Although testing in the Laboratory for Hydrospheric Processes was done on the single-drive Sony, the processing scenarios are similar when using the "jukebox" installed at either the University of Miami or NASA/GSFC Coastal Zone Color Scanner (CZCS) global processing sites. The [OPTICAL...] directories on your VAX or MicroVAX contain the JUKE_MANAGER executables and related files.

I. DATABASE CONSIDERATIONS

The JUKE_MANAGER software communicates with an RDB database installed on the DEC VAX or MicroVAX containing the Sony WORM drive(s). The database, which at NASA/GSFC is the same one used for performing quality control (QC) on CZCS data, contains information related to the project name of optical disks in the archive, as well as the names of files present on these disks, volume label, version of the JUKE_MANAGER software used, disk status (open, closed, blank, currently being written), date initialized, registration date, number of free blocks, names of accounts writing to the disk, comments, etc. In order for the JUKE_MANAGER to allow read or write access to a disk, it must recognize the project name already on a previously-written disk or one to be assigned by the user for a new disk. A new project name can be written to relation LASER_DISK at the time of database creation or at a later point, by the database manager for your site. This chapter assumes that valid project names have been installed in your database, and you are ready to read/write a disk.

II. VMS CONSIDERATIONS

1. Privileges - There are no special system privileges needed for reading optical disks on the Sony when outside the JUKE_MANAGER. However, in order to use the JUKE_MANAGER for both reading and writing disks, the following system privileges are necessary: PHYS_IO, LOG_IO, SYSPRV and VOLPRO. Since these give the user a high degree of control over the system, it is suggested that great care be taken in creating an account for accessing the Sony. Preferably, a single experienced user should be charged with accessing the Sony drive for writing disks. If this is not possible, a "captive" account could be set up which can only access the JUKE_MANAGER. For example, at the NASA/GSFC Laboratory for Hydrospheric Processes, an account named "SONY" has been set up on node DIATOM for this purpose.

2. Logical names - The following logicals need to be set correctly before running the JUKE_MANAGER. These are located in the file "logicals.com" in the [OPTICAL] directory:

a. LASER_DATABASE - Defines the location of the RDB database mentioned above (i.e. SATDAT_DATABASE:GODDARD). This normally will not change once it is set.

b. LASER_SOFTWARE - Defines the version of the JUKE_MANAGER being run (i.e. JUKEPACK 1.0). It need only be changed with each revision to the software you receive.

c. LASER_SITE_NAME - Defines the local site where the JUKE_MANAGER is being run. It also serves as the prefix for the disk names assigned to new disks at initialization time (i.e. GSFC, NSSDC). The site name should ideally be six characters or less, since only 12 characters (including a six-digit sequence number) will be recognized in the full disk name. LASER_SITE_NAME is also set just once for a given site.

d. LASER_DISK_DRIVE - Defines the Sony device type (i.e. OSD1 for a single drive system). It will be set once for each site, unless the configuration is changed.

e. LASER_INIT_FILE - Defines the name of a file located in directory [OPTICAL.SOAR] having extension ".INP". This name will be used to define the category name for a disk to be initialized with the JUKE_MANAGER. This file is discussed below.

f. LASER_SPOOL_DIR - Defines the name of the optical disk directory to be written to when the Sony is accessed (i.e. [WINDS]).

Note: Items "e" and "f" will change with the optical disk and can be defined in a file separate from LOGICALS.COM, and executed after it, in order to override its default settings.

3. Files Required

a. .INP file - The logical name LASER_INIT_FILE points to a file which contains directory name and size information for a new disk to be initialized. This file should have an extension of ".INP" and be located in directory [OPTICAL.SOAR]. For example, a file named "WINDS.INP" will be used to define the directory structure on a newly initialized disk if "WINDS" is specified as the category name when option 5 ("Initialize disk in jukebox") is chosen from the JUKE_MANAGER menu and LASER_INIT_FILE is set to "WINDS". The file generally contains a single line of information in the following form:

[Sony directory name]/expected number of files to be written to directory

2 OPTICAL DRIVE AND JUKE MANAGER

For example, a WINDS.INP file with the line:

```
[WINDS1]/1000
```

will result in the creation of a directory [WINDS1] on one side of the Sony disk. The specification of "1000" means that a maximum of 1000 files will be written to this side of the disk. If the maximum number is not exactly known ahead of time, an estimate can be obtained by dividing the capacity of a side in VAX blocks (3,276,000) by the size of the smallest file to be written. Unless most of the files are the same size, this estimate will be too large but this will not adversely impact the JUKE_MANAGER.

III. RUNNING THE JUKE_MANAGER

The JUKE_MANAGER software can be used for both reading and writing optical disks on the Sony WDD-3000 drive. Each disk (model WDM-3DL0) can be thought of as a large square phonograph record, with two sides for writing. Each side can hold approximately 3.25 million VAX blocks, or 1.6 gigabytes, of information. These data can be read or written out at speeds of up to 400,000 blocks per hour. Writing is done to one side of a disk at a time. The disk must first be registered and initialized before any writing in order to assign a disk name and create a directory structure. When writing is complete to one side, it is "closed"--that is, no more writing to this side is allowed, and the database is updated with information on the files contained therein--and the second side is then written. Reading can be done on either "open" or "closed" disks or sides of disks. Each side of the disk can be thought of as a separate entity, as far as the database is concerned. A separate entry is made in the database for each side in terms of a volume label, status code, and all other informational fields discussed above. However, it should be noted that both sides of the disk must be associated with the same project and category designations.

1. Starting Up the JUKE_MANAGER - If you are logging into a captive account, the Sony menu should appear automatically. If you are logging into a non-captive account (which must have certain system privileges), simply type "sony" from the DCL prompt to activate the Sony menu. The login file for this account should, at a minimum, contain the following lines:

Assuming the [OPTICAL] account is located on drive SIA1,

```
$ set default SIA1:[OPTICAL]
```

```
$ @set          This defines certain symbols, runs LOGICALS.COM to  
                define the LASER__ logical names and runs  
                [OPTICAL.SCSI]SETUP.COM to establish the controller  
                and drive names and check necessary privileges.
```

A local set of logicals defining LASER_INIT_FILE and LASER_SPOOL_DIR could be placed after the "@set" line. An additional line needs to be included if the user intends to use the utility program "A", described in a separate section below, as follows:

```
$ setup 0 (drive number 0 or 1) (physical drive name)
      This defines controller number 0, drive 0 or 1 if
      you have two single drives and the corresponding
      physical drive--e.g., "setup 0 0 ldb0".
```

After typing "sony" a group of lines similar to the following appears:

```
you are SONY
site is GSFC-OCEANS
software is JUKEPACK 1.0
local disk drive is OSD1 (single drive)
laser disc init file is WINDS
laser disc spool dir is [WINDS1]
```

1. Insert disk into jukebox
2. Register disk in jukebox
3. Remove disk from jukebox
4. Check jukebox/database for consistency
5. Initialize disk in jukebox
6. Mount an open project disk in jukebox
9. Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

what would you like to do?

The first section above displays the account name accessing the Sony, as well as the settings of the various logical names. The main menu follows.

2. General description of Sony menu items

a. Choice 1 - "Insert disk into jukebox" - For a new disk, this is used to do a logical (software) insert of the disk into the drive. For closed disks, this also loads the disk's filenames into the database. It is suggested that choice 1 always be the first thing done when entering the menu, unless the user is certain that the disk is open or it is closed and contents have already been loaded by running the insert previously. When insert has already been run, the user can use choice 6 to logically mount the disk more quickly. In this case, more care must be taken to insure that the correct side is up. (The disk is written or read from the

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bottom. Therefore, if "B" side is loaded upward, the "A" side is actually being written.) The disk should be physically loaded in the drive before doing the software insert. For consistency, when using choice 1, the disk should always be loaded with the same side up (the "A" side is suggested). Simply place it in the Sony drive slot and apply a slight pressure. The disk will drop into the drive in a manner similar to the loading of a VCR tape. The JUKE_MANAGER will prompt you to flip and reinsert it at least once.

Choice 1 will typically lead to the following response from the JUKE_MANAGER when the disk is blank:

```
what would you like to do?
1
put disk on shelf          1
blank disk .. you should register disk on shelf          1
no file structure on default side
Please turn disk over and put back in drive, <cr> when ready

second side of this disk is unregistered
no file structure on second side
```

Note the request for turning the disk over at the midway point. The references to the need for registration and for a file structure will be addressed in choices 2 and 5 below.

If you get the message:

```
%Insert-E-BUSY, Disk already present in drive
```

this means that a software dismount was not done the last time the JUKE_MANAGER was exited. You can run choice 3 ("Remove disk from jukebox") at this point to perform the software dismount as well as a physical ejection of the disk, followed by choice 1 again. The only effect of choice 3 is the ejection of the disk--the menu will simply rewrite itself on the screen, without any messages for the user.

b. Choice 2 - "Register disk in jukebox" - Each new disk must be registered with the database so that it is assigned a unique name. This name is formed from the site name with a sequence number appended and is written to the disk and to the database when choice 2 is selected. The response from the host will look like the following:

```
what would you like to do?
2
%REGISTER-I-DO, Process disk on shelf          1
check default side
disk size is          3276000
Please insert other side of disc, <cr> when ready
```

look at other side
register other side
wrote registration to other side
Please insert other side of disc, <cr> when ready

register default side
wrote registration to default side
disk successfully registered

c. Choice 3 - "Remove disk from jukebox" - This performs both a physical and logical removal of the disk from the Sony drive. It should be used immediately before exiting the JUKE_MANAGER. If you select choice 3 when there is no disk physically mounted in the drive you will get the message:

%REMOVE-E-EMPTY, No disk in drive

d. Choice 4 - "Check jukebox/database for consistency" - This compares the contents of a disk to what is written in the database, and can be used to revise the database if necessary. It should be used following a power interruption or another event causing an abnormal termination to a write operation.

e. Choice 5 - "Initialize disk in jukebox" - This creates a volume label on the disk formed by the project name suffixed with a sequence number. Also, a directory structure is created on the disk, using the specifications of the .INP file. Lastly, a binary file containing a list of the files written to the disk is created on the host's disk in logical name SOAR. A sample exchange with the host follows:

what would you like to do?

5

enter project [ENV]

ENVDATA

enter category

COADS

shelf = 1

side = 1

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%LaserINIT-I-LABEL, Volume label is ENVDATA0004

%OINIT-I-CREMAGFIL, Creating file SOAR:ENVDATA0004.\$SOAR\$ with
2208 contiguous blocks

we initialized side 1

adjust info for side 2

force project on second side

force category on second side

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If the user accidentally tries to initialize a disk which has already been initialized, the following message will appear:

%LaserINIT-E-OPEN, Open disk ENVDATA0004 present for project ENVDATA

f. Choice 6 - "Mount an open project disk in jukebox" - This choice is used to logically mount and write to an open disk. An abbreviated menu will appear. The disk should have been previously installed physically into the Sony drive with the side to write to (if applicable) pointing DOWNWARD in the drive. This choice should be used if you wish to mount an open disk simply to check its contents (with a DIR command), and is recommended if you wish to write groups of files in "chunks" (i.e., not all at one time) because the disk is not dismounted after each group write as it is when using menu choice 12. A typical exchange follows:

what would you like to do?

6

enter project [ENVDATA]

enter category [COADS]

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

7. Copy a file to jukebox

8. Dismount disk in jukebox

13. Spawn a sub-process

14. Exit

Note: Entry of an incorrect project or category (i.e., one not recognized by the RDB database) or an attempt at mounting a closed disk with this option would have given the message:

%LaserMOUNT-F-NONE, No open disk for specified project

Trying to run choice 6 before the disk is physically loaded and logically inserted in the drive would give the message:

%LaserMOUNT-F-UNAVAIL, Disk is unavailable

The options in the abbreviated menu are herein described:

- Choice 7 - "Copy a file to jukebox" - Actually, this can allow multiple files to be written to LASER__SPOOL_DIR on the disk, depending on the user's file specification. The user specifies any

valid search pattern and the JUKE_MANAGER lists the applicable files and their sizes in Vax blocks. The user decides whether to copy all of the files or just certain ones and whether to rename or delete the files from disk (or do nothing) after copying to optical. This can continue indefinitely until a slash ("/") terminator is typed in. A sample session follows:

what would you like to do?

7

3274644 blocks available on optical disk

%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /

CDF\$DAT:46* GROUP3.*;

%LaserCOPY-E-INVPattern, Invalid search pattern

%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /

%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /

SIA0:[SEAPAK.CDF]46* GROUP3.C*;

1 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1 9

2 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /

SIA1:[SEAPAK.CDF]46* GROUP6.C*;

3 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1 9

4 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /

/

30 blocks in selected files

3273644 blocks available on optical disk

%LaserCOPY-I-OKALL, Accept all names for copy?

Y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to
optical disc [delete, rename, nothing]

DELETE

%LaserCOPY-I-DELETE, Files will be deleted after copy completes

%LaserCOPY-I-START, File copy starting

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 17.8 seconds

%LaserCOPY-E-DELETE, Couldn't delete file, status = 98970

new_laser_file-d-search, result is 0

%LaserCOPY-E-FAILED, Copy failed

[NOTE: File delete failed due to incorrect protection setting under VMS, so the write operation was rerun as is seen below. This time nothing is done to the magnetic disk files after copying to optical, until the protection can be fixed.]

7. Copy a file to jukebox

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- 8. Dismount disk in jukebox
- 13. Spawn a sub-process
- 14. Exit

what would you like to do?

7

3274636 blocks available on optical disk

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

SIA0:[SEAPAK.CDF]46*_GROUP3.C*;

1 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1 9

2 SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

SIA1:[SEAPAK.CDF]46*_GROUP6.*;

3 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1 9

4 SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

/

30 blocks in selected files

3273636 blocks available on optical disk

%LaserCOPY-I-OKALL, Accept all names for copy?

Y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to optical disc [delete, rename, nothing]

NOTHING

%LaserCOPY-I-START, File copy starting

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 3.5 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP3.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 2.4 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 2.1 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-COPY, Copying file

SIA1:[SEAPAK.CDF]4601-4912_COADS_MSTG_GROUP6.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 2.1 seconds
new_laser_file-d-search, result is 0

%LaserCOPY-I-END, File copy complete

A variation of the above scenario occurs when you want to select only certain files from a specified group for copying. You will be prompted for what to do with each file individually. Typing "y" will result in it being copied, while typing "n" or hitting a carriage return will result in the file not being copied:

what would you like to do?

7

1720716 blocks available on optical disk
%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /
sia0:[seapak.cdf]60*_group6.c*;
1 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDF;1 9
2 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1 6
%LaserCOPY-I-SEARCH, Search location for files, terminate
searching with /
/

15 blocks in selected files
1719716 blocks available on optical disk
%LaserCOPY-I-OKALL, Accept all names for copy?
n
1 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDF;1 9 ?
2 SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1 6 ?
y

6 blocks in selected files
1719716 blocks available on optical disk
%LaserCOPY-I-ADJUST, Adjust files after successful copy to
optical disc [delete, rename, nothing]
nothing
%LaserCOPY-I-START, File copy starting
%LaserCOPY-I-COPY, Copying file
SIA0:[SEAPAK.CDF]6001-6912_COADS_MSTG_GROUP6.CDH;1
%LaserCOPY-I-TIMING, Copy completed in 2.5 seconds
new_laser_file-d-search, result is 0
%LaserCOPY-I-END, File copy complete

- 7. Copy a file to jukebox
- 8. Dismount disk in jukebox
- 13. Spawn a sub-process
- 14. Exit

- Choice 8 - "Dismount disk in jukebox" - This performs a logical dismount of the disk only. Option 3 in the main menu would still need to be run to physically remove the disk from the drive. The user is returned to the main menu following choice 8's selection.

- Choice 13 - "Spawn a sub-process" - This brings the user into DCL as a sub-process of the main JUKE_MANAGER process. Typically the user may want to check file locations on the magnetic disk or, in the case of an open optical disk, the current inventory of files on the disk. When doing this, the user should remember that, for an open disk mounted, the laser drive is considered a virtual device so that the device name on the host system will typically appear as QSB0 or QSB1, even though the physical device might be LDB0 or LDB1. A sample exchange follows:

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what would you like to do?

13

Juke-Spawn>dir OPTICAL:[coads_mstg1]

[NOTE: The logical name OPTICAL replaces the need to know the actual device name (which is actually QSB0: or QSB1:).]

Directory QSB0:[COADS_MSTG1]

4601-4912_COADS_MSTG_GROUP3.CDF;1

4601-4912_COADS_MSTG_GROUP3.CDH;1

4601-4912_COADS_MSTG_GROUP4.CDF;1

4601-4912_COADS_MSTG_GROUP4.CDH;1

Total of 4 files.

Juke-Spawn>lo

Process SONY_1 logged out at 30-DEC-1988 13:23:31.68
Back in Juke_Manager

7. Copy a file to jukebox
8. Dismount disk in jukebox
13. Spawn a sub-process
14. Exit

- Choice 14 - "Exit" - This exits the JUKE_MANAGER entirely, performing only a logical dismount of the disk and returning the user to DCL. The exchange with the host will resemble the following:

what would you like to do?

14

%LaserMOUNT-W-DISMOUNT, Dismounting volume ENVDATA0004
\$

g. Choice 9 - "Close out completed disk" - This will finalize the writing of files to the current side of the disk. The binary file list, containing an accounting of all files written to the current side, is copied from magnetic disk to the optical disk and renamed to have a name of "(Optical disk volume name).DOC". A sample exchange follows:

what would you like to do?

9

enter project [ENVDATA]

enter category [COADS]

Are you really sure? [n]

[NOTE: You can change your mind and return to the main menu.]

1. Insert disk into jukebox
2. Register disk in jukebox

3. Remove disk from jukebox
4. Check jukebox/database for consistency
5. Initialize disk in jukebox
6. Mount an open project disk in jukebox
9. Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

what would you like to do?

9

enter project [ENVDATA]

enter category [COADS]

Are you really sure? [n]

y

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

%LaserCOPY-I-COPY, Copying file

DUA0:[OPTICAL.SOAR]ENVDATA0004.DOC;1

%LaserCOPY-I-TIMING, Copy completed in 2.2 seconds

new_laser_file-d-search, result is 0

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$QSB0:

%MOUNT-I-MOUNTED, mounted on _DIATOM\$LDB0:

h. Choice 10 - "Mount a disk in jukebox" - This is used to do a software or logical mount of either an open or closed disk for the purpose of reading or checking files from it. This choice is similar to choice 6 except that the user cannot write files to the Sony. A sample exchange follows:

what would you like to do?

10

%LaserMOUNT-I-LABEL, Volume name of disk to mount ENVDATA0001

disk size is 3276000

disk registered by JIMF

at archive site GSFC-OCEANS on 8-DEC-1988 16:03:37

using software JUKEPACK 1.0

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with serial no. 1
and disk name GSFC-OCEANS000001
%MOUNT-I-MOUNTED, ENVDATA0001 mounted on _DIATOM\$QSB0:

- 8. Dismount disk in jukebox
- 13. Spawn a sub-process
- 14. Exit

what would you like to do?

At this point, the user may choose item 13 to spawn a sub-process, then use a "dir" command to check the files on the disk, or possibly "copy" to move files to magnetic disk from the Sony.

i. Choice 11 - "Read in selected files" - This follows the mounting of an open or closed disk using choices 6 or 10, and is used for copying certain files to magnetic disk from the Sony drive. A sample exchange follows:

what would you like to do?
11
Enter search pattern or / to stop searching
46*_group3.c*
Searching via pattern "46*_GROUP3.C*"
1 [COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDF;1 on
ENVDATA0004 <online>
2 [COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDH;1 on
ENVDATA0004 <online>
Enter search pattern or / to stop searching
/
All matches approved for copy?
y
Where do you want the files written?
sial:[seapak.cdf]
disk size is 3276000
disk registered by SONY
at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14
using software JUKEPACK 1.0
with serial no. 4
and disk name GSFC-OCEANS000002
found volume label
%MOUNT-I-MOUNTED, ENVDATA0004 mounted on _DIATOM\$LDB0:
%LaserCOPY-I-COPY, Copying file
LDB0:[COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDF;1
%LaserCOPY-I-TIMING, Copy completed in 2.7 seconds
%LaserCOPY-I-COPY, Copying file
LDB0:[COADS_MSTG1]4601-4912_COADS_MSTG_GROUP3.CDH;1
%LaserCOPY-I-TIMING, Copy completed in 2.2 seconds

A variation of the above occurs when the user selects a group of files then decides to read only certain ones in the group:

```

what would you like to do?
11
Enter search pattern or / to stop searching
0179_0679_fnoc_uv.c*
Searching starting with "0179_0679_FNOC_UV.C"
      1  [WINDS1]0179_0679_FNOC_UV.CDF;1 on ENVDATA0001
<online>
      2  [WINDS1]0179_0679_FNOC_UV.CDH;1 on ENVDATA0001
<online>
Enter search pattern or / to stop searching
/
All matches approved for copy?
n
[WINDS1]0179_0679_FNOC_UV.CDF;1 ?
y
[WINDS1]0179_0679_FNOC_UV.CDH;1 ?
n
      1  [WINDS1]0179_0679_FNOC_UV.CDF;1 on ENVDATA0001
<online>
All matches approved for copy?
y
Where do you want the files written?
sial:[sony]
disk size is      3276000
disk registered by JIMF
  at archive site  GSFC-OCEANS on  8-DEC-1988 16:03:37
  using software   JUKEPACK 1.0
  with serial no.   1
  and disk name     GSFC-OCEANS000001
%MOUNT-I-MOUNTED, ENVDATA0001 mounted on _DIATOM$QSB0:
%LaserCOPY-I-COPY, Copying file
QSB0:[WINDS1]0179_0679_FNOC_UV.CDF;1
%LaserCOPY-I-TIMING, Copy completed in      2.9 seconds

1.  Insert disk into jukebox
2.  Register disk in jukebox
3.  Remove disk from jukebox
4.  Check jukebox/database for consistency
5.  Initialize disk in jukebox
6.  Mount an open project disk in jukebox
9.  Close out completed disk
10. Mount a disk in jukebox
11. Read in selected files
12. Write out selected files
13. Spawn a sub-process
14. Exit

```

what would you like to do?

j. Choice 12 - "Write out selected files" - This is used for copying certain files from magnetic disk to the Sony drive. This choice will mount the disk with the specified project and category

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and then prompt the user for the filenames to be copied, then dismount the disk when the user indicates they are finished. If no appropriate disk is currently available to write the files to, the user will be prompted for a fresh disk, which will be inserted, registered and initialized (if necessary). The effect is similar to choosing number 6 from the main menu to mount the disk, followed by choice 7 in the submenu to write to the disk and then choice 8 in the submenu to dismount the disk. One advantage of using the second method is the option to spawn a sub-process (submenu choice 13) in order to check magnetic disk directories, etc. A sample exchange follows:

what would you like to do?

12

enter project

ENVDATA

enter category

COADS

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

sia0:[seapak.cdf]70*_group6.c*;

1 SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDF;1 9

2 SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDH;1 6

%LaserCOPY-I-SEARCH, Search location for files, terminate searching with /

/

15 blocks in selected files

%LaserCOPY-I-OKALL, Accept all names for copy?

y

%LaserCOPY-I-ADJUST, Adjust files after successful copy to optical disc [delete, rename, nothing]

nothing

%LaserCOPY-I-START, File copy starting

* see if open project disc is available

* mount open disc for write: ENVDATA0004

disk size is 3276000

disk registered by SONY

at archive site GSFC-OCEANS on 30-DEC-1988 09:18:14

using software JUKEPACK 1.0

with serial no. 4

and disk name GSFC-OCEANS000002

%MOUNT-I-MOUNTED, ENVDATA0004 mounted on DIATOM\$QSB0:

* file size 9, space left 1355140

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDF;1

%LaserCOPY-I-TIMING, Copy completed in 4.2 seconds

new_laser_file-d-search, result is 0

* file size 6, space left 1355132

%LaserCOPY-I-COPY, Copying file

SIA0:[SEAPAK.CDF]7001-7912_COADS_MSTG_GROUP6.CDH;1

%LaserCOPY-I-TIMING, Copy completed in 4.2 seconds

new_laser_file-d-search, result is 0

%LaserCOPY-I-END, File copy complete
%LaserCOPY-I-DMOUNT, Dismount disk

k. Choice 13 - "Spawn a sub-process" - This is the same as the description for choice 13 above which is in the submenu when an open disk is mounted (main menu choice 6). The only difference is that typing "lo" to terminate the sub-process here will return the user to the main JUKE_MANAGER menu.

l. Choice 14 - "Exit" - This exits the JUKE_MANAGER entirely. Note that this only does a logical dismount of the disk. As a result, the JUKE_MANAGER will think the disk is still in the drive the next time it is invoked. This can be remedied by running main menu choice 3 (remove disk) before choice 14. This will also do the physical dismount for removing the disk from the drive.

IV. SUMMARY OF PROCESSING SEQUENCES FOR READING, WRITING AND CHECKING OPTICAL DISKS

This section summarizes the order of operations which should be performed to read or write optical disks. Separate subsections are included for disks which are open, closed and blank.

1. Reading files from an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #11 (read in files).
- d. decide which files will be read in (the RDB database will be searched for these names).
- e. specify disk and directory destination for these files.
- f1. if disk in Sony is incorrect, disk will be ejected and proper disk will be requested.
- f2. if the other side of disk in Sony is the correct one, the disk will be ejected with a request to flip it over.
- g. disk will be mounted and files copied to the specified destination.
- h. if files span more than one side of a disk, the current disk will be ejected and the next disk/side will be requested as per f1 and f2 above.
- i. after all files have been read in the disk will be dismounted.
- j. select main menu #3 (remove disk) - disk will be ejected.
- k. select main menu #14 (exit JUKE_MANAGER).

2. Reading files from a CLOSED optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #11 (read in files) - follow the prompts.

- d. decide which files will be read in (the RDB database will be searched for these names).
- e. specify disk and directory destination for these files.
- f1. if disk in Sony is incorrect, disk will be ejected and proper disk will be requested.
- f2. if the other side of disk in Sony is the correct one, the disk will be ejected with a request to flip it over.
- g. disk will be mounted and files copied to the specified destination.
- h. if files span more than one side of a disk, the current disk will be ejected and the next disk/side will be requested as per f1 and f2 above.
- i. after all files have been read in the disk will be dismounted.
- j. select main menu #3 (remove disk) - disk will be ejected.
- k. select main menu #14 (exit JUKE_MANAGER).

3. Writing files to a BLANK optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #2 (register disk).
- d. select main menu #5 (initialize disk).
- e. select main menu #6 (mount open disk) or #12 (write out files).
- f. select submenu #7 (copy file) after main menu #6, or follow prompts after main menu #12. Either choice will prompt for the file names to be written out and what to do with them after successful writing (rename, delete, nothing), and main menu #12 will also prompt for the project/category. The files will be written out one at a time. If the next file in sequence will not fit on the current open disk, then the open disk will be closed, and operations will continue as described in "Notes" below beginning at the asterisk.

[Notes on mounting of disk: If an open project disk is available, it will be mounted if in the drive. If this disk is not in the drive, the disk in the drive will be ejected and an open disk will be requested. *If no open disk is available, a registered disk will be requested (if available). If a registered disk is requested but none is available, a blank disk will be requested and will be initialized.]

- g. select submenu #8 (dismount disk) (after main menu #6 only; main menu #12 will do this for you).
- h. select main menu #3 (remove disk) - disk will be ejected.
- i. select main menu #14 (exit JUKE_MANAGER).

4. Writing files to an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.

- c. select main menu #6 (mount open disk) or #12 (write out files).
- d. select submenu #7 (copy file) after main menu #6, or follow prompts after main menu #12. Either choice will prompt for the file names to be written out and what to do with them after successful writing (rename, delete, nothing), and main menu #12 will also prompt for the project/category. The files will be written out one at a time. If the next file in sequence will not fit on the current open disk, then the open disk will be closed, and operations will continue as described in "Notes" below beginning at the asterisk.

[Notes on mounting of disk: If an open project disk is available, it will be mounted if in the drive. If this disk is not in the drive, the disk in the drive will be ejected and an open disk will be requested. *If no open disk is available, a registered disk will be requested (if available). If a registered disk is requested but none is available, a blank disk will be requested and will be initialized.]

- e. select submenu #8 (dismount disk) (after main menu #6 only; main menu #12 will do this for you).
- f. select main menu #3 (remove disk) - disk will be ejected.
- g. select main menu #14 (exit JUKE_MANAGER).

5. Writing files to an CLOSED optical disk with the JUKE_MANAGER

This cannot be done.

6. Checking files on an OPEN optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #6 (mount open disk).
- d. select submenu #13 (spawn a sub-process).
- e. execute the command "dir OPTICAL:[(dir name)](filenames)" to check for existence of files.
- f. terminate the sub-process by typing "lo" when finished.
- g. select submenu #8 (dismount disk).
- h. select main menu #3 (remove disk) - disk will be ejected.
- i. select main menu #14 (exit JUKE_MANAGER).

7. Checking files on a CLOSED optical disk with the JUKE_MANAGER

- a. physically insert disk into drive, "A" side up.
- b. select main menu #1 (insert disk); flip disk when prompted.
- c. select main menu #13 (spawn a sub-process).
- d. execute the command "dir OPTICAL:[(dir name)](filenames)" to check for existence of files.
- e. terminate the sub-process by typing "lo" when finished.
- f. select main menu #3 (remove disk) - disk will be ejected.
- g. select main menu #14 (exit JUKE_MANAGER).

8. Checking/reading files on OPEN or CLOSED optical disks without the JUKE MANAGER

[NOTE: At NASA/GSFC Laboratory for Hydrospheric Processes, this can be done from any user account on node DIATOM, because the setup procedure has been modified so as not to check privileges. No special privileges are needed for reading only.]

- a. physically insert disk into drive, with the side to read facing down.
- b. Goddard "SEAPAK" users: type "sonym 0" (for drive DIATOM::LDB0) or "sonym 1" (for drive DIATOM::LDB1) to mount and set up the disk for reading.

OR

- b. non-SEAPAK users: type in the DCL sequence described under "Starting Up the JUKE_MANAGER" subsection above. Add the following:

```
$ mount /over=id (drive name, i.e. ldb0: or ldb1:) /noassist
```

- c. execute the DCL command
"dir ldb0(or ldb1):[(dir name)](filenames)" to check for existence of files, or use the "backup" or "copy" command to copy files to magnetic disk. You can also print the .DOC file in LDB0:[000000] or LDB1:[000000] for a file list. Goddard users note: Copying CZCS archive files from the Univ. of Miami platters takes about 7 seconds per file.
- d. Goddard "SEAPAK" users: type "sonyd 0" or "sonyd 1" to logically dismount and spin down the disk; use the "Emergency eject" button on the left side of the drive unit to physically remove the disk from the Sony.

OR

- d. non-SEAPAK users: from DCL type "dism ldb0:" followed by "a eject" to physically eject the disk.

V. THE UTILITY PROGRAM "A"

This program is available from privileged accounts only. The options are:

1. Type "a eject" to physically eject the platter before logging out.
2. Type "a stop" to spin down the platter. This is also done when you use the "dismount" command in DCL.
3. Type "a start" to spin up a platter.

4. Type "a sense" to see if the controller is working. A code 0 means everything is normal, while a code 6 means there is a controller error.
5. Type "a inquire" to get information on the type of media in the drive. A sample output follows:

Write-Once Read-Multiple Vendor: SONY Product: WDC-2000-10
Rev: 1.00
Removable media
Disk loaded

Acknowledgements: Thanks to Jim Brown at the University of Miami and Gene Feldman at NASA/GSFC for their assistance in using the Sony WORM disk drive.

DATA PROCESSING DESCRIPTIONS

- A. Logging On and Displaying an Image**
- B. Ingesting Level-1 Data**
- C. Generating CZCS Level-2 Products**
- D. Projecting Multiple Images to a Common Map**
- E. Using STATDIS to Generate Images from Image Data Files**
- F. Formats of SEAPAK Image and Control Point Files**
- G. Environmental Data Processing Scenarios**

LOGGING ON AND DISPLAYING AN IMAGE

The basic steps to display an image on the IIS are:

- 1) Select CPU corresponding with the IIS being used
- 2) Log onto the computer
- 3) Enter "SEAPAK"
- 4) Allocate an IIS
- 5) Initialize the IIS
- 6) Use the program IMAGE to display the desired image
- 7) If another image is to be displayed, repeat step 6
- 8) When finished, log off

The detailed steps to accomplish this vary depending on the TAE mode one is using, i.e. the Menu, Tutor or Command mode. A brief description for each of these modes follows. See the earlier section describing TAE for more information. Detailed descriptions of individual programs are given elsewhere in this guide.

MENU MODE:

- 1) Selecting a CPU via a Decserver:
 <Carriage Return> <---- This gets the Decserver's
 attention
 ENTER USERNAME> Name <---- Enter the user's name
 LOCAL> Connect CPU Name <---- Enter the CPU name
 after typing
 "Connect" (or "C")
- 2) Logging onto the VAX:
 USERNAME: Account Name <---- Enter the account
 name here
 PASSWORD: Password <---- Enter password here
- 3) Entering SEAPAK:
 \$SEAPAK <---- This activates SEAPAK if the user's
 LOGIN.COM file has been setup properly
 with all the symbols defined.
 SEAPAK>MENU <---- This puts SEAPAK into the Menu
 Mode. Note that the abbreviation
 "M" is sufficient.

To understand the input numbers in what follows, check the menu tree. The individual programs and their associated parameters are described in detail in the Reference section of this manual.

- 4) Allocating an IIS (numbers represent items in the menu which are subject to change):
 ? 1 <---- Selects the SEAPAK menu
 ? 5 <---- Selects the IIS image display menu

- ? 1 <---- Selects the IIS initialization menu
- ? 1 <---- Selects the program ALLOC which reserves a specific IIS for the user. Enter the parameter requested and type RUN.

- 5) Initializing the IIS:
 - ? 2 <---- Selects the program INT from the INITIAL menu. This initializes the IIS. Enter the parameter requested (CLRMEM=YES) and type RUN.

- 6) Displaying an Image on the IIS:
 - ? BACK <---- This moves the user from the INITIAL menu to the DISPLAY menu.
 - ? 2 <---- This selects the IIS memory management menu.
 - ? 1 <---- Selects the program IMAGE which drops or displays an image on the IIS. Enter the parameters requested and type RUN.

- 7) If one wants to display more images:
 - ? 1 <---- This will select IMAGE again

- 8) If one wants to log off the computer:
 - ? LO <---- This will log the user off.

TUTOR MODE:

- 1) Selecting the proper CPU, logging on and entering SEAPAK are the same as for the Menu mode except one does not type MENU to get into the Menu mode.
- 2) Allocating an IIS:
 - SEAPAK>TUTOR ALLOC <---- This puts one into the tutor or menu mode for the program ALLOC which reserves a specific IIS for the user. Enter the parameter requested and type RUN. Note that "Tutor" can always be abbreviated by "T".

- 3) Initializing the IIS:
 - SEAPAK>TUTOR INT <---- This puts one into the tutor or menu mode for the program INT. Enter the parameter requested (CLRMEM=YES) and type RUN. This initializes the IIS.

- ```

4) Displaying an Image on the IIS:
 SEAPAK>TUTOR IMAGE <---- This puts one into the tutor
 or menu mode for the program
 IMAGE which drops or displays
 an image on the IIS. Enter
 the parameters requested and
 type RUN.

5) Repeat step 4 if one wants to display more images. If
 ready to log off:
 SEAPAK>LO

```

**COMMAND MODE:**

- ```

1) Selecting the proper CPU, logging on and entering
SEAPAK are the same as for the Menu mode except one
does not type MENU to get into the Menu mode.

2) SEAPAK>ALLOC ATLANTIC <---- Allocates the IIS named
Atlantic. If one is
using Pacific, type this
rather than Atlantic.

SEAPAK>INT YES <---- This initializes the IIS.

SEAPAK>IMAGE Image_File_Name IIS_Channel_Number
<---- This displays the specified
image file in the given IIS
channel.

SEAPAK>LO <---- If one wants to log off; else,
repeat the "IMAGE" command if there
are more to display.

```


INGESTING LEVEL-1 DATA

In this section, the generation of CZCS and AVHRR level-1 images from tape files will be discussed. The CZCS level-1 files normally have 970 scan lines per file, but may have fewer, and 1968 samples per scan line. Level-2 products from the CZCS must be generated separately (see the section on generating CZCS level-2 products). The programs TP2IMG and TP2DSK are used to create 512x512 disk image files from level-1 tape files of CZCS and DK2IMG creates such image files from level-1 disk files. However, TP2DSK may also be used for to ingest up to three complete 970x1968 (full-scan) CZCS scenes from a tape as one set of files from which 512x512 image files may be extracted using the program WINDOW. This approach is often more convenient than using TP2IMG or DK2IMG since it permits the user to visually determine the location of the extracted image in the overall scene.

Unlike CZCS files, AVHRR tape files from NOAA can be any number of scan lines. Also, the AVHRR local area coverage (LAC) data has 2048 and global area coverage (GAC) data has 409 samples per scan line. Sea-surface temperature (SST) level-2 products are created when the AVHRR data ingest program AV2IMG is used.

See the individual help sections of the programs mentioned for more detailed information.

Using TP2IMG and DK2IMG: The programs TP2IMG and DK2IMG are used to ingest individual level-1 CZCS scenes and create 512x512 pixel images. Both programs work the same way except that TP2IMG uses tape files as input whereas DK2IMG requires disk input files. In addition to the creation of full-resolution images (reduction factors of 0), positive reduction factors may be used to subsample the data, since the level-1 scene may have up to 970 scan lines of 1968 samples, and negative reduction factors may be used to create images magnified by pixel duplication. Using TP2IMG and DK2IMG requires a little arithmetic unless one assumes the file is a full scene and an overview is desired (reduction factors 4 and 2 for samples and scans, respectively). Usually, a user will want to generate a set of overview images in order to see the full scene. From the overview images, the coordinates of subimages can be determined and they are usually used in the Angstrom exponent determinations required by the level-2 programs discussed in the section on generating CZCS level-2 products.

In SEAPAK, image files of each CZCS band are created independently of the others. Systems like the University of Miami's DSP interleave the data from each channel resulting in one file per scene(s). SEAPAK creates six image files and one control point file which contains the navigation data. For TP2IMG and DK2IMG, the user provides a root name and extension for the image files and the band numbers are appended to the root name automatically. The control point file is simply the root name with a ".CTL" extension (rootname.ctl). Each file format convention has its advantages and

disadvantages. Separation of the image files allows users to easily delete unnecessary files, such as IR-band images, thus saving disk space, but requires more file management.

Finally, if the subscene the user is interested in spans more than one scene, MERGE can be used to combine several scenes into one 512x512 image, subsampling if necessary.

Using TP2DSK and WINDOW: Rather than ingesting reduced-resolution CZCS scenes one at a time to obtain an overview and then reading in subscenes for merging as described above, the combination of the programs TP2DSK and WINDOW may be used. For TP2DSK, all one needs to specify are the sequence number of the first file and the number of files to be read from the tape. The files must be consecutive satellite scenes as they normally are on tapes obtained from NASA or NOAA. The output is one large file containing the scenes' data at full-resolution. If significantly large gaps exist between the scenes, execution will not be completed. Currently, up to three files can be ingested in this way.

The program WINDOW is very easy to use. The IIS memory is utilized in such a way that the entire data file may be roamed at full resolution or displayed as an overview at reduced resolution by simply toggling a button. The user defines a box using the IIS button pad which will have dimensions that are multiples of 512 pixels in each direction. Single images from one CZCS band or all the bands can be generated that correspond to the current box position. When the appropriate function key is depressed, the user will be prompted for the filenames required. The program automatically uses the boxed area to create a 512x512 sized image, subsampling if necessary.

Using AV2IMG: This program is used to ingest an AVHRR scene of HRPT, LAC or GAC data from a tape in the format of those generated by NOAA/NESDIS/NCDC/SDSD (Kidwell, 1988) as well as to generate the SST image. The data must be in packed format, with time incrementing, and be a full set copy (as opposed to selective extract subsets where certain channels are selected). Unlike CZCS scenes, the AVHRR scene in this format may contain variable scan line numbers. The program allows the user to scan the tape scene first, if the user has no information of the input scene, in order to get the starting and ending scan line numbers for the windowing and reduction factor parameters. Also, since the AVHRR scenes may be obtained while the satellite is ascending (flying south to north) or descending (north to south), the enumeration of the samples and scan lines may be reversed. See the TPAVHRR program section for more detailed information.

GENERATING CZCS LEVEL-2 PRODUCTS

The SEAPAK CZCS level-2 menu includes a number of tools to assist the user in determining the input parameters required to generate level-2 products. Only a few are normally employed in the routine production of level-2 products (usually THRES, CLRWAT, and L2MULT), while several of the others are special purpose programs (L2DUAL, L2GAC, EPSILON and L2BOXD). L2MULT, L2SNGL and L2DUAL create images of subsurface water radiance (or, optionally, normalized water-leaving radiance) at 443nm, 520nm and 550nm, aerosol radiance at 670nm, pigment concentration and Rayleigh radiance at 443nm. In this discussion, the term "water radiance" will apply to subsurface water radiance, while water-leaving radiance and normalized water-leaving radiance refer to radiances just above the air-water interface. These will be discussed in more detail later. A selection of Rayleigh scattering models is available and include single scattering (L2SNGL) and two multiple scattering methods (L2MULT). The multiple scattering model of Gordon et al. (1988) is recommended since it is the most sophisticated model available for CZCS analysis and is the model used in the CZCS global processing project (Esaias et al., 1986; Feldman et al., 1989). While the Rayleigh radiances are not standard global processing products, SEAPAK includes the 443 Rayleigh radiance field because it is a useful diagnostic quantity when other standard products seem unreasonable. Also, SEAPAK does not generate the diffuse attenuation field K(490), which is a standard global processing product, since there has not been a demand for it by any of the GSFC investigators using SEAPAK.

L2BOX and L2BOXD allow the user to roam a scene using the cursor and compute the values of the level-2 products within a box while providing the flexibility of changing input parameters such as the calibration correction factors, the aerosol correction parameters and the ozone optical thicknesses. Other products such as images of the epsilon values in 443nm, 520nm and 550nm can be generated using EPSILON by making certain assumptions about the water radiance fields.

The primary parameters required for generating level-2 products are the aerosol correction parameters (the Angstrom exponents or epsilons) and the land/cloud and aerosol flag thresholds. Programs such as CLRWAT, SCREEN, and ANGST are designed to help determine the aerosol correction parameters while THRES may be used to fine tune the land/cloud and aerosol flags.

Other parameters, such as the calibration correction factors and the ozone optical thicknesses, can also be varied. However, the use of calibration correction factors other than the default values is not recommended since such factors are not easily determined unless additional field observations of upwelling water radiance are available. Likewise, alternate ozone thicknesses should be used with caution since the default thicknesses are derived from the Total Ozone Mapping Spectrometer (TOMS) data for

the time and location of the scene in question. Once the level-2 products are created, the land/cloud thresholds may be modified using FLAGLC and LANCLD to create new versions of the images without rerunning the level-2 program. If the user wishes to use a standard set of input parameters on a group of scenes, SPBATCH can be used to run all the jobs at once in a batch mode. In this section, a typical sequence of steps for generating standard level-2 images from a set of level-1 images will be discussed.

Step 1: Determining the Angstrom exponents and the land/cloud flags. In the global CZCS processing mentioned above, Angstrom exponents equal to 0 are used on all scenes and no attempt is made to compute Angstrom exponents for each scene. The terms Angstrom exponent and epsilon are both used interchangeably in discussing the aerosol correction. The reader is referred to Gordon et al. (1983) for a discussion of the terms which are related by the following equation:

$$e(\lambda) = (\lambda/670)^{n(\lambda)}$$

where λ is the wavelength (443, 520 or 550), and $e(\lambda)$ and $n(\lambda)$ are the epsilon and Angstrom exponent, respectively. So, for an epsilon equal to 1, the Angstrom exponent is 0. As epsilon increases, the Angstrom exponent becomes more negative. One of the assumptions in the atmospheric correction algorithm is that the aerosol radiance at 670nm is related to the aerosol radiances at 520nm and 550nm through this equation. Another assumption is that these do not change within a scene. The Angstrom exponent at 443nm is taken to be the average of the values at 520nm and 550nm because the water radiances at 443nm are too variable even in clear water for stable estimates to be derived.

In areas dominated by marine haze such as in the central gyres and along the western continental margins, Angstrom exponents of 0 (or epsilons of 1) are usually adequate. However, in regions influenced by continental haze such as the eastern U.S. coast and the Mediterranean Sea, these values often fail to remove the haze resulting in contamination of the level-2 products by underestimating the aerosol radiance. This produces an overestimation of the water radiance and an underestimation of pigment concentration. On the other hand, high concentrations of dust are often encountered in the eastern tropical Atlantic Ocean, the western Pacific Ocean, and the Arabian Sea. These conditions can cause the 670nm band to saturate making an atmospheric correction impossible. The HAZE parameter (of program L2MULT, for example) has a default value of 254 which flags all saturated pixels, although some conditions may require the flag to be set lower. Dust contaminated data usually require Angstrom exponents greater than zero. One should always compare the water radiance and pigment images with the aerosol radiance or level-1 670nm radiance image to determine if features are correlated. If the haze is correctly removed, there should be no correlation.

2 GENERATING CZCS LEVEL-2 PRODUCTS

When dense or continental haze is present, the user may try CLRWAT in an attempt to find a better set of Angstrom exponents. CLRWAT is described in the program reference volume of this manual. CLRWAT has two modes, user-interactive and automated and uses a set of criteria to eliminate pixels from consideration. Some of these criteria may be adjusted by the user. Solar zenith and spacecraft zenith angles are examples. If the sun is too low in the sky, the radiative transfer models may not work well enough for the estimation of the Angstrom exponents. Aerosol radiance is another example. If the haze is too dense or too small, the estimation of the Angstrom exponents will not be valid for the rest of the scene. Also, pixels which fail the land/cloud flag are eliminated. Defaults settings are provided for all these. In the interactive mode, the user roams the scene with a box cursor looking for the set of Angstrom exponents associated with the lowest value of a quantity called CLOW. CLOW is the ratio $e(443)/La(670)$ where $La(670)$ is the aerosol radiance.

This procedure was developed by the Nimbus Experiment Team (NET) and is presented in Williams et al. (1985), but the rationale behind it was never discussed. It has been used by SEAPAK users for several years and has been found to yield consistent and quite acceptable results (see Barale et al., 1986, and McClain et al., 1988). The best locations to search are those with very low pigments because the 670nm radiances will not be affected by the ocean's reflectance. Care must be taken to avoid pixels affected by sensor ringing on the down-scan side of bright areas such as clouds (Mueller, 1988; see the help text for the program RING), an effect that is most noticeable in the 670nm image. In addition, fringe areas around clouds that are not flagged by the land/cloud threshold can cause erroneous estimates of CLOW.

In the automated mode, the user sets the maximum pigment threshold in order to ensure that clear-water pixels are used. The program then computes the epsilon frequency distributions at 443nm, 520nm and 550nm from all valid pixels. Certain statistics are derived from the frequency distributions and may be output to a text file. These include the minimum, the maximum, the mean, the median, the mean of the lowest 10%, and the standard deviation. From these, the user can select a set of epsilon values to use. The automated mode also creates a special image whose pixel values indicate the rejection criterion for invalid pixels as well as the clear-water pixels that passed all criteria. This special image may be displayed using the program SCREEN to color the various pixels according to each pixel's category.

When using CLRWAT, care must be taken to set the cloud threshold properly. The default works in most situations, but care must be taken to avoid thin clouds and areas where the 670nm radiances are saturated. Band 5 (750nm) was designed for land/cloud identification. Clouds at low solar elevations tend to be less bright, so if the solar zenith angle is high (the program DMPHDR can be used to find out) or if there are a lot of thin clouds, the default value of 21 counts (gray levels) in the 750nm image may need to be reduced. THRES or READ can be used to

determine the "best" threshold. In general, it is advisable to use the level-1 670nm image for the interactive use of CLRWAT because it is sensitive to haze, clouds and ringing.

If CLRWAT does not yield useful results, ANGST is often helpful. ANGST is based on a technique developed by Arnone and LaViolette (1984) and is designed to allow the user to interactively remove haze from the level-1 443nm, 520nm and 550nm bands using the 670nm band as the reference aerosol band. In ANGST, one operates on each band separately using the trackball to fine tune the haze removal. This is particularly useful when there is a specific haze feature to be removed. In this way, incremental increases in the Angstrom exponents can be made until there is no evidence of the feature left in the water radiance images. The program allows the user to check the water radiance values in the scene using the cursor and to stretch the image contrast in order to see more clearly the features. In using the level-2 programs which require Angstrom exponents, the same Rayleigh scattering model must be used as was used in determining the Angstrom exponents.

Step 2: Using L2MULT. (See the detailed description of L2MULT in the programs volume for more information on options and parameters). Once the Angstrom exponents and the land/cloud flag are determined, L2MULT is used to generate the level-2 products. In L2MULT, two multiple scattering algorithms are available and are selected using the MULTIS parameter. The "exact" option is recommended. The program is designed to provide as much flexibility as possible in the selection of algorithms and input parameters. An inexperienced person should stick with the defaults provided for parameters such as the ozone optical thicknesses, the calibration algorithm, the multiple scattering algorithm, the pigment algorithm, water radiance range and the method used for the aerosol correction (ITERATE is the selection parameter).

The user is given the choice of generating subsurface upwelling water radiance or normalized water-leaving radiance (Gordon and Clark, 1981) images. The parameter is NORMWAT. The transformation from subsurface water radiance to water-leaving radiance is a function of the Fresnel reflectivity and the index of refraction. However, it is wavelength independent and cancels out when ratios are used in the pigment algorithm. Normalized water-leaving radiances have the solar zenith angle dependence removed and therefore have the advantage of being nearly constant at 520nm and 550nm in clear water regions. The normalized 443nm water-leaving radiances are variable because of the great sensitivity to pigment concentration at 443nm, even in clear water regions. At this time, algorithms for deriving other quantities from normalized radiances have not been developed. Finally, the user is given the option of applying the Smith and Wilson (1981) iteration method for computing the water and aerosol radiance fields. This option creates a seventh output field for water radiance at 670nm since it does not assume that water radiance at 670nm is zero as does the Gordon et al. (1983) algorithm. For each pixel, if the algorithm

does not converge after 10 iterations, it is assumed to be an invalid pixel and a 0 gray level (black) is assigned to all output images at that pixel.

One input which may require some advance consideration is the cloud flag. In L2MULT, the 443nm level-1 radiances are used with the 750nm (band 5) radiances to discriminate land from clouds if the MASKLC parameter is set to "YES". In this case, pixels which are brighter than the CLOUD threshold gray level value and which are also flagged by the LANCLD threshold will be set to a 255 gray level (white) in the level-2 images. Pixels which fail the LANCLD threshold, but pass the CLOUD threshold are set to a 0 gray level value. If the CLOUD threshold used results in black areas over the ocean, this pixels may be changed to 255 values using LUTMOD (described in the programs volume) with having to regenerate the level-2 products. Also, if the threshold for the LANCLD parameter was not optimal, the program FLAGLC or LANCLD can be used to modify the level-2 images.

There are two pigment algorithms from which to select. The parameter is PIGMENT. One is the standard, two-channel "branching" algorithm of Gordon et al. (1983). This algorithm switches from an equation based on water radiances in the 443nm and 550nm bands to one based on the 520nm and 550nm bands once the concentration reaches 1.5. In this case, SEAPAK also switches to the 520nm-550nm equation once the 443nm subsurface water radiance drops below 0.15. This is done because of imperfections in the switching logic which occasionally allow the 443nm-550nm combination to be used even though it yields values much greater than 1.5. The exact algorithm as implemented in SEAPAK is

1. if $Lw(550) \leq 0$, then $P = 40.84719$ (saturated); else,
2. if $Lw(443) > 0.15$,
 - then $P = A2 * (Lw(443)/Lw(550))^{B2}$, (A)
 - where $\log_{10}(A2) = 0.053$ and $B2 = -1.71$;
 - if $P \geq 1.5$ and $Lw(520) > 0$
 - then $P = A4 * (Lw(520)/Lw(550))^{B4}$, (B)
 - where $\log_{10}(A4) = 0.522$ and $B4 = -2.44$;
 - if $P < 1.5$, then use (A) above;
3. if $Lw(443) \leq 0.15$ and $Lw(520) > 0$, then use (B) above;
4. if $Lw(443) \leq 0.15$ and $Lw(520) \leq 0$,
 - then $P = 40.84719$ (saturated);

where Lw represents the water-leaving radiance for the band of the specified wavelength (nm) and P is the pigment concentration in mg/m^3 .

The other algorithm uses a three-channel equation provided by Dennis Clark (see Muller-Karger et al., 1990):

1. if (Lw(550)>0) and (Lw(443)>0 or Lw(520)>0), then

$$\text{RATIO} = [\max(\text{Lw}(443), 0) + \max(\text{Lw}(520), 0)] / \text{Lw}(550)$$

$$P = 5.56 * \text{RATIO}^{(-2.252)}; \text{ else,}$$
2. P = 40.84719 (saturated).

This algorithm does not involve a switching of equations that often results in a minimum for the pigment frequency distribution of the two-channel algorithm.

Finally, L2MULT and several other programs including CLRWAT and ANGST allow the user to change the calibration of bands 1 to 4. In the case of multiple scattering, only two options are provided, "Evans" and "User." The parameter is CORR. The CZCS suffered a severe calibration degradation or sensitivity loss which was erratic. Several algorithms were proposed by various investigators to correct for this and all are necessarily coupled to the Rayleigh scattering model they used. The reason for this coupling is that all techniques utilize either direct sea truth measurements or assume clear water radiances over the open ocean and the calibration is adjusted so as to match those values with the assumption that the Angstrom exponents in clear water regions are zero.

The Evans scheme (unpublished; used in the global CZCS processing) is the only one available which corresponds to the multiple scattering model of Gordon et al. (1988). The user should only try defining his own correction factors (FACTOR) when testing the sensitivity of the level-2 products or when he is trying to compare with sea truth observations. These calibration factors only multiply the calibration term as given in Gordon et al. (1983a) and do not change the slope and intercept numbers in that term. The Evans calibration modifies the slopes and intercepts for each gain setting and includes a time-dependent correction factor as well. There must be consistency between the calibration used in deriving the Angstrom exponents and that used in L2MULT.

The conversion of CZCS counts to total radiance (Lt), or calibration, uses the following general equation:

$$Lt(b) = [\text{Counts}(b) * \text{SLOPE}(b) + \text{INTCP}(b)] * \text{FACTOR}(b)$$

where SLOPE and INTCP are the equations slope and intercept, FACTOR is the correction factor, and b is a CZCS band (channel) number 1 to 4. For the "Evans" option, SLOPE, INTCP, and FACTOR are calculated as follows:

$$\begin{aligned} \text{SLOPE}(b) &= \text{SLP}(b,g) * \text{MULTG}(b,g) * \text{SMULT}(b) * \\ &\quad [C(b,o) - (A(b,o) * \text{Orbit})] \\ \text{INTCP}(b) &= \text{INT}(b,g) * \text{MULTG}(b,g) * \text{IMULT}(b) \\ \text{FACTOR}(b) &= 1.0 \end{aligned}$$

where SLP and INT are the unmodified calibration slope and intercept, MULTG is a gain-dependent multiplier to SLP and INT,

6 GENERATING CZCS LEVEL-2 PRODUCTS

Table 1. Values of time-independent "Evans" parameters.

<u>parameter</u>	<u>gain</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
SLP	1	0.04452	0.03103	0.02467	0.01136
	2	0.03589	0.02493	0.02015	0.00897
	3	0.02968	0.02032	0.01643	0.00741
	4	0.02113	0.01486	0.01181	0.00535
INT	1	0.03963	0.05361	0.06992	0.01136
	2	0.03963	0.06361	0.06992	0.01136
	3	0.03963	0.06461	0.08292	0.01136
	4	0.03963	0.06361	0.07992	0.01136
MULTG	1	1.057	0.969	0.958	1.008
	2	1.060	0.970	0.947	1.020
	3	1.050	0.975	0.931	1.016
	4	1.059	0.960	0.934	1.010
SMULT	--	0.983	1.013	1.017	1.000
IMULT	--	1.0	1.0	1.146	1.0

SMULT and IMULT are gain-independent multipliers to SLP and INT, and C and A are the intercept and slope of a time-dependent (orbit number) correction to SLP. The indices g and o represent the sensor gain and orbit. The values of SLP, INT, MULTG, SMULT, and IMULT are listed in Table 1, and those of C and A are listed in Table 2. For the "user" option, SLOPE and INTCP are obtained from Table 3 and FACTOR is as specified by the user.

Once the level-2 products have been created, gray level and geophysical values may be examined using programs such as READ, RLINE and HIST. For linearly scaled quantities, the slope and intercept are stored in the file header and are read by these programs in order to transform gray levels to geophysical values. READ allows the user to roam the image and examine values within a user-defined box or at individual points. RLINE allows the user to examine values along lines and HIST can be used to examine the frequency distributions.

Table 2. Values of time-dependent "Evans" parameters.

<u>par.</u>	<u>orbit no.</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
A	<5001	-1.700E-05	-5.000E-06	-2.000E-06	0.0
	5001-6750	-6.000E-05	-5.000E-06	-2.000E-06	0.0
	6751-20000	-1.457E-05	-9.770E-06	-6.620E-06	0.0
	>20000	-1.700E-05	-6.000E-06	-5.000E-06	-5.000E-06
C	<5001	1.0	1.0	1.0	1.0
	5001-6750	0.785	1.0	1.0	1.0
	6751-20000	1.092	0.967	0.968	1.0
	>20000	1.0426	1.042	0.9995	0.9

Table 3. Slopes and intercepts for "user" option (from Gordon et al., 1983).

<u>parameter</u>	<u>gain</u>	<u>band 1</u>	<u>band 2</u>	<u>band 3</u>	<u>band 4</u>
SLOPE	1	0.04452	0.03103	0.02467	0.01136
	2	0.03598	0.02493	0.02015	0.00897
	3	0.02968	0.02032	0.01643	0.00741
	4	0.02113	0.01486	0.01181	0.00535
INTCP	1	0.03963	0.06361	0.07992	0.01136
	2	0.05276	0.08826	0.06247	0.03587
	3	0.02879	0.09752	0.06570	0.02963
	4	0.03359	0.05647	0.04723	0.01646

All image files are in a one byte per pixel, binary format with pixel values scaled from 0 to 255. In programs such as L2MULT, the user may decide the water radiance scaling by setting the radiance limits using the WATER parameter, but the defaults are 0 to 2.55 mw/(steradian-micron-cm²). The water, aerosol and 443 Rayleigh radiances are all linear functions of gray level. The water radiance values are adjustable because some scenes may have features with radiances greater than 2.55. Aerosol radiance is scaled for values 0 to 2.55. Rayleigh radiance is scaled according to the minimum and maximum values for the scene and, therefore, its scaling varies from scene to scene.

For pigment concentrations (mg/m³), SEAPAK calculates the gray level values using the NET's scaling convention:

```

if (PIGMENT ≤ 1.0) then
  GRAY_LEVEL = nint( 98.38*log10(PIGMENT) + 136.0 )
else
  GRAY_LEVEL = nint( 74.17*log10(PIGMENT) + 136.0 )
end if

```

("Nint" is a function to round to the nearest integer.) The global processing pigment products are generated using the University of Miami DSP system's scaling conversion for pigment (mg/m³) which is defined as

$$\text{GRAY_LEVEL} = \text{nint}((\log_{10}(\text{PIGMENT}) + 1.4)/0.012)$$

with gray scale limits of 2 through 245 (or 1.5 to 245.49 before rounding, corresponding to pigment values of 0.0415 to 35.15).

Acknowledgements: The tables used by SEAPAK for the Rayleigh scattering computations were contributed by Howard R. Gordon, James W. Brown, and Robert H. Evans of the University of Miami. Values for Tables 1 and 2 presented here are from Robert H. Evans.

PROJECTING MULTIPLE IMAGES TO A COMMON MAP

The projection of images to a common map is often required in image analysis when studying a set of associated images. The study of a time series of images over a certain general region (Case 1) or the use of a number of images to form a single composite image covering a wider geographical area (Case 2) are two occasions where such projection is required. In both cases the images are projected to a common imaginary map and the images may or may not actually overlap with each other in geographical area. This section will describe how the projection program MAPIMG may be used to perform projection of multiple images for these two cases.

When the navigation information associated with an image is incorrect, the geocoordinates (as obtained by the program LATLON, for example) of image landmarks will also not be correct. Such images may be corrected using the program REGIST which will simply shift the gray level values relative to their pixel/line (TV) coordinates. (A monitor display of 512 pixels by 512 lines is assumed in this discussion.) This correction may be done independently of the use of MAPIMG which will map the corrected or uncorrected image using the same navigation information. Navigation data for CZCS scenes are usually accurate to within three pixels.

When using MAPIMG it is useful to think of the display (monitor) as a window or view area over an imaginary map of the world. A mapped image output by MAPIMG will normally have a portion or all of the area of the input image visible within this window. For Case 1, output images are often partially outside the window (lost) since each image in the series of images is likely to cover the earth area of interest to a different extent. Therefore the map of the world being considered is often much larger than the window for Case 1. For Case 2 however, output images are likely to be entirely within the window which will cover a large portion of, if not the entire, map. Case 2 output images can also be thought of as various pieces of a map puzzle (or mosaic) which may or may not be completely filled in.

"Output image" as used here refers to the input image as it would appear on the world map. The actual image created by MAPIMG, and contained in the file OUTFILE, is that of the window area of the map which may or may not include all of this "output image." If part of the output image is outside the window, it will be lost (i.e. not included in OUTFILE). Conversely, window pixels that are not within the output image boundary will be black (and stored in OUTFILE as such).

Controlling the Projection Characteristics of the Output

The MAPIMG input parameter PROJECTN determines the projection of the output image as well as of the imaginary map of the world of which it is a part. Although the image is projected onto that map,

the input parameters LL_1, LL_2, PIXEL, LINE, and DELTA_P allow the user to control where the window will be positioned over the map as well as the scale of the map. If defaulted, these parameters will be set such that the window will be directly over the output image area of the map and the map's scale will be such that this image will take up as much of the window as possible while remaining entirely within it. These default values are optimal for cases where images are being studied individually instead of as a group. Since these five parameters are used in conjunction with each other, if any one of them is defaulted, they will all be defaulted regardless of any values entered for some.

If no defaults are used, the PIXEL and LINE parameters refer to the TV coordinates of a point on the window whereas LL_1 refers to the geocoordinates (latitude and longitude) of a point on the world map. The points will be associated so that the window point overlays the map point. For a Case 1 study, the user may find it convenient to choose LL_1 to be in the center of the earth region of interest and assign it PIXEL/LINE values of 256/256, the center of the display (window). Alternatively, the user may wish that a certain landmark appear at a certain location on the display. In such a case, the landmark's geocoordinates would be entered for LL_1 and the desired display location specified by PIXEL/LINE. Similarly for Case 2, the geocoordinates of the geographical center of the desired composite image may be entered for LL_1 and 256/256 for PIXEL/LINE.

The use of parameters LL_2 and DELTA_P in conjunction with LL_1, PIXEL, and LINE controls the scale of the map and, hence, also controls how much of the mapped image appears on the display (i.e., within the window). LL_2 represents the geocoordinates of another point on the world map and DELTA_P represents the separation in pixels between that point and the PIXEL/LINE window location. A positive DELTA_P represents a horizontal separation, whereas a negative value represents a vertical separation.

Note that this second point need not be within the window and that the absolute value of DELTA_P may be larger than the display width or height (512 pixels or lines). For given parameters, a larger absolute DELTA_P will decrease the geographical area covered by the window (enlarge the map); a smaller absolute value will increase this area (contract the map). The direction of the second point relative to the first--that is, where they both fall on the world map--is determined solely by the projection.

Although DELTA_P represents the separation in either the horizontal or vertical direction (not the absolute separation), the points for LL_1 and LL_2 must be chosen such that they have both a horizontal AND vertical separation on the imaginary map. Therefore some a priori knowledge of where these points will fall on that map is required when choosing these parameter values.

A convenient way to determine values for LL_2 and DELTA_P is to use the geocoordinates of another landmark for LL_2 and enter the desired separation between LL_1 and LL_2 for DELTA_P. Another convenient way to determine these values is to determine the scale for the map at LL_1. (In certain cases, depending on the projec-

2 PROJECTING IMAGES

tion, the scale will vary greatly even within the window area.) That is, the user decides how many display pixels (DELTA_P) should separate a longitudinal or latitudinal degree, minute, or second and assign LL_2 and DELTA_P accordingly. For example, if the scale at LL_1 is to be one latitudinal degree per 100 pixels and LL_1 is 10 degrees latitude and 38 degrees longitude, LL_2 would be 9 and 38 degrees and DELTA_P would be -100 (assuming that north is on top for this projection).

When being run interactively and the parameter DYNNAME is the null value ("--"), MAPIMG will prompt the user for dynamic parameters soon after it has been initiated. Which parameters are requested depends on the projection that was specified.

It is important to understand that the default values for these dynamic parameters are calculated on the basis of the input image since the geographical characteristics for the map within the window have not been determined at this point. (These parameters are themselves used in the projection calculations and so, what the map would look like cannot be known at this point.) For example, if PROJECTN is 1 (UTM projection), the value for ZONE will be the number of the UTM zone in which is located the longitudinal midpoint of the input image. This ZONE value may be different from that desired for the common map onto which a series of images are being projection as described in the following paragraphs.

The dynamic parameter default values are meant to serve as a best guess for the map area that appears within the window area assuming that LL_1, LL_2, PIXEL, LINE, and DELTA_P are defaulted. Therefore it is up to the user to set these values so that they correspond to the desired map region within the window. For example, if the midpoint of this region is used for the zone in a UTM projection, this region will be at the center of a UTM-projected (imaginary) world map; if a point to the west of this region is used to determine this zone, the region will be on the right side of such a map.

When the map area within the window is large relative to the output image, as is often true for Case 2 studies, it is important to visualize this map area when deciding these dynamic parameter values. For instance, if an entire Van der Grinten (PROJECTN=19) world map will be within the window, the user may choose the central meridian such that the center of the map features the Americas, Europe/Africa, or the Atlantic or Pacific Oceans.

The input parameter ASPECT enables the user to modify the aspect ratio of the world map by stretching or contracting the horizontal and vertical aspects independently of each other. ASPECT is applied after the projection characteristics are determined by the program and so is independent of all other parameters. Since ASPECT may change the technical characteristics of a projection (a Van der Grinten projection, for example, will no longer be a Van der Grinten projection if ASPECT is not 1), a value other than 1 (the default) should only be used for special purposes such as to allow room on the display area for a caption, for example, or to permit a split screen display of more than one image.

Once the input parameters PROJECTN, LL_1, LL_2, PIXEL, LINE, DELTA_P, and ASPECT and the dynamic parameters have been established for one image, the same values must be used for the other input images in the set. This applies for both, Case 1 and 2, studies. These parameters determine the characteristics of the world map onto which the input images will be projected as well as the view area of the window.

Executing MAPIMG in Batch Mode

Because MAPIMG may be run numerous times for a given study requiring several minutes for each execution, the program has been designed to enable batch execution even though it requires dynamic parameters. The input parameter DYNNAME determines which dynamic parameter values are used during a batch execution. If DYNNAME is the null value and MAPIMG is run in batch mode, the default values calculated for the dynamic parameters and which would have been displayed on the dynamic tutor screen, will be used automatically.

To run in batch mode with non-default values for the dynamic parameters, the user must first save these values in a parameter file and enter this file name for DYNNAME. MAPIMG would first be run interactively with the null value for DYNNAME until the dynamic parameters' prompt or tutor screen is obtained. At this point the user can enter the desired values and save them into a parameter file with the SAVE command before continuing with the program or terminating it with the EXIT command. When the parameter file name is entered as the value of DYNNAME in subsequent batch runs (instead of the default null value), MAPIMG will automatically obtain the required values from the specified parameter file. Of course, PROJECTN must be the same so that the parameters saved in the file match those required during the batch execution.

Note that when DYNNAME is set to a parameter file name in interactive execution, MAPIMG will also automatically access this file for the required values without prompting or tutoring the user for the dynamic parameters. A more complete discussion of interactive and batch executions, the use of parameter files, and TAE commands is given in a separate discussion of TAE elsewhere in this manual.

Using Multiple Input Files

Although MAPIMG allows multiple image files as input (INFILE may represent seven files), these must be geographically identical such as the images of different bands of the same scene. MAPIMG will use the navigation information from the first file and apply it to all the others. If these images are not geographically identical, only the first one will be mapped correctly. As an obvious example, if the first image is of Florida while the others are of Japan, the geocoordinates of points in the Japan images (as determined by LATLON, for example) will correspond to those of the

Florida image. Therefore, MAPIMG must be run separately for each scene in a Case 1 or 2 study.

USING STATDIS TO GENERATE IMAGES FROM IMAGE DATA FILES

Some SEAPAK programs create image "data" files instead of regular SEAPAK image files. Regular files use a byte to store the value of each image pixel so that each pixel may have an integer value of 0 to 255. Data files, on the other hand, use a real number (four bytes) to represent each pixel. The precision for real data is much greater than for byte data: about one part per 8.4 million versus one part per 255. It is therefore very advantageous to perform image calculations using real pixel numbers instead of bytes values. For this reason, programs such as ADDF, MEANF, MULTF, LOGF, and DERIV generate data image files as output which may then be converted to regular image files using the program STATDIS. The image files generated by STATDIS may then be displayed directly on the IIS Model 75.

The optimal conversion (mapping) of the real data into values of 0 to 255 depends on the distribution of the data. The most straightforward mapping would be to assign the minimum to 0, the maximum to 255, and interpolate linearly for intermediate values. This is the mapping function used by STATDIS to display the initial image from an input linear data image. However, if the data are concentrated over a relatively small portion of their range, this mapping may result in a great loss of resolution for these data. Therefore a primary function of STATDIS is to allow the user to optimize a linear mapping by specifying a smaller data range to be mapped. STATDIS may also be used to assign the same mapping to multiple images of the same geophysical quantity since it is desirable that for such images the gray shades (or pseudocolors) represent the same magnitudes.

Note that since the pigment concentration-to-gray-level mapping is non-linear and is preset, STATDIS does not permit pigment image mappings to be varied.

Because of the larger storage requirements of data image files (four bytes instead of one byte per pixel), a user may choose to create such files only for a certain region of interest defined by a blotch. If so, that blotch must be used with STATDIS so that STATDIS can reconstruct the image area represented by the corresponding data image file.

The following describes the possible steps needed to create, for a given blotch area, an image resulting from the mathematical manipulation of other images in SEAPAK:

1. Allocate an IIS Model 75 display system using ALLOC.
2. Initialize the display using INT and possibly GRPINTL.
3. Use IMAGE to display the image(s) of interest.
4. Use BLOTCH to define a blotch for the region of interest over the displayed image.
5. Use BPSAV to save the blotch displayed as a disk file.
6. Perform the desired mathematical calculations on the image file(s) for the defined blotch and generate the

data image file. Programs such as ADDF and DERIV generate such files and allow the user to specify a blotch file for the calculations.

7. Invoke STATDIS while the blotch defined in step 4 is displayed on the monitor.
8. Use STATDIS to determine the image gray level mapping, save the image as a regular image file, and delete the corresponding (input) data image file if it is no longer needed.
9. Deallocate the display system using DEALLOC or by exiting SEAPAK.

FORMATS OF SEAPAK IMAGE AND CONTROL POINT FILES

Standard SEAPAK image files that can be dropped into the IIS Model 75 memory channels for display are simple flat files of 512 logical records, each of which is 512-bytes long. Each logical record corresponds to an image line when displayed and each byte corresponds to the pixels on that line. Additional 512-byte records containing header information may precede the image data. These image files normally contain one such header record. Files containing overlay graphics (also referred to as blotch files), are identical in structure except that they do not include any header records.

Users need not normally be concerned with the contents of an image file's header. However, a header's information may be examined using the program DMPHDR. The program MODHDR is provided for the rare occasion when a user may wish to change certain of this information. A complete list of the parameters retained in the header, their data types, and their locations, is presented in Table 1. Note that parameters may be for informational purpose only (i.e., they do not impact any program's calculations), may have more than one meaning depending on the context (i.e. the

Table 1. Contents of SEAPAK image file header.

<u>Byte</u>	<u>Description</u>	<u>Format</u>
1-4	area code	I*4
5-6	start year	I*2
7-8	start day	I*2
9-12	start msec	I*4
13-14	orbit number	I*2
15-34	spare	
35-36	gain	I*2
37-38	threshold	I*2
39-40	solar elevation (scene center)	I*2
41-42	solar azimuth (scene center)	I*2
43-44	roll (scene center)	I*2
45-46	pitch (scene center)	I*2
47-48	yaw (scene center)	I*2
49-52	gray-to-data slope	R*4
53-72	spare	
73-76	gray-to-data intercept	R*4
77-96	spare	
97-98	starting pixel of tape ingesting	I*2
99-100	starting line of tape ingesting	I*2
101-102	ending pixel of tape ingesting	I*2
103-104	total lines on tape ingesting	I*2
105-106	pixel reduction factor	I*2

Table 1. Contents of SEAPAK image file header. (Cont'd)

<u>Byte</u>	<u>Description</u>	<u>Format</u>
107-108	line reduction factor	I*2
109-110	spare	
111-112	tilt angle	I*2
113-128	spare	
129-132	minimum latitude in the image	R*4
133-136	maximum latitude in the image	R*4
137-140	minimum longitude in the image	R*4
141-144	maximum longitude in the image	R*4
145-146	control points per image line	I*2
147-148	control points per pixel column	I*2
149-164	image corner latitudes	4(R*4)
165-180	image corner longitudes	4(R*4)
181-184	increment in msec	I*4
185-200	four epsilons	4(R*4)
201-236	control point file name	A*36
237-256	five circle parameters	5(R*4)
257-258	display offset	I*2
259-260	stamp for derived images	I*2
261-262	spare	I*2
263-264	normalized water radiance flag	I*2
265-280	spare	
281-282	MAPIMG projection index	I*2
283-284	UTM or SPC zone	I*2
285-344	15 projection parameters	15(R*4)
345-346	spare	
347-348	data source	C*2
	C1 - CZCS level-1 image	
	C2 - CZCS level-2 image	
	A6,A7,A8,A9,AA,AB - AVHRR-6,7,8,9,10,11	
	M2 - U. of Miami DSP	
	G - gridded image	
349-350	data type	C*2
	L1 - CZCS or AVHRR level-1	
	TR - total radiance	
	PI - pigment	
	SC - CZCS SST	
	SA - AVHRR SST	
	WR - water radiance	
	RA - Rayleigh radiance	
	AT - AVHRR thermal bands	
	DA - diffuse attenuation	
351-352	band number	I*2
353-354	starting pixel of image	I*2
355-356	ending pixel of image	I*2
357-358	starting line of image	I*2
359-360	ending line of image	I*2
361-512	spare	

settings of flags and the program in question), or may be reserved for future use.

Except for images containing gridded data, unmapped images created by such programs as the ingest programs and DSPIMG are each associated with a control point file. Such files contain the navigation information for their corresponding images and are denoted by the extension ".CTL" in their filenames. This information consists essentially of a set of geocoordinates (latitude/longitude pairs) corresponding to a set of display coordinates (pixel/line pairs). These display coordinates are also referred to as control points. From these data, the geocoordinates of all other image pixels can be interpolated for program calculations requiring earth locations. The format of control point files is explained in the following paragraph, although the user is cautioned that modifying such files may cause errors in programs using these data.

Control point files are ASCII files containing certain variables in the following logical records:

<u>record</u>	<u>parameter</u>	<u>Fortran format</u>
1	NCPP, NCPL, "1"	3I10
2	CPPIX	8I10/
3	CPLIN	8I10/
4	LATMIN, LATMAX, LONMIN, LONMAX, DATLIN	4F12.7,I10
5	CPLAT	8F12.7/
6	CPLON	8F12.7/

Records 5 and 6 are repeated NCPL times, one pair for each CPLIN value. The definitions of these variables are:

NCPP: Number of control points per image line (control point pixels); 1 to 100; usually 26.

NCPL: Number of control points per pixel column (control point lines); 1 to 100; usually 26.

"1": Flag indicating that it is a new format control point file, described herein; the new format was adopted in April 1988 to allow more flexibility in mapping images to different projections.

CPPIX: Unmapped pixel indices of control points; run from small to large (left to right on the image display); NCPP values ranging from 1 to 512.

CPLIN: Unmapped line indices of control points; run from small to large (top to bottom on the image display); NCPL values ranging from 1 to 512.

LATMIN: Southernmost CPLAT value.

LATMAX: Northernmost CPLAT value.

LOMIN: Westernmost CPLON value.

LOMAX: Easternmost CPLON value.

DATLIN: Equals -1 if 180 deg. longitude crosses the control point field; else, equals 0; may be used as a logical variable.

CPLAT: Latitudes (+-90 decimal degrees) of control points; each CPLAT record contains NCPP values, one for each CPIX

value; there are NCPL CPLAT records, one for each CPLIN value; read in as a two dimensional array where the first index represents the horizontal (pixel) display direction and the second represents the vertical (line) direction; e.g., CPLAT(3,4), the third value of the fourth CPLAT record, is the latitude for the pixel CPPIX(3) on line CPLIN(4); the order of lines run N to S and the order of pixels run W to E.

CPLON: Longitudes (+-180 decimal degrees) of control points; each CPLON record contains NCPP values, one for each CPPIX value; there are NCPL CPLON records, one for each CPLIN value; read in as a two dimensional array where the first index represents the horizontal (pixel) display direction and the second represents the vertical (line) direction; e.g., CPLON(3,4), the third value of the fourth CPLON record, is the longitude for the pixel CPPIX(3) on line CPLIN(4); the order of lines run N to S and the order of pixels run W to E.

In SEAPAK, level-3 images refer to those created by the projection program MAPIMG. Level-3 images contain the values of their projection equation parameters in their headers and are not associated with control point files.

ENVIRONMENTAL DATA PROCESSING SCENARIOS

The basic strategy for generating a specific type of output depends on the type of input data (gridded or ungridded) and how many time periods are being processed. Gridded data are stored in the Common Data Format (CDF) defined by the NASA Climate Data System (NCDS) at the National Space Science Data Center (NSSDC) based at NASA/GSFC. CDF is a self-describing format containing not only data but information about the data (Treinish and Gough, 1987). SEAPAK has the capability to extract any spatial/temporal limits from these datasets, subsample both spatially and temporally, average the data at specified time intervals, and then display the data in one of several ways.

One particularly useful method is to convert the gridded data to a gray scale image which is stored in SEAPAK image format using the program ENVIMG. This image is then usable by the remainder of SEAPAK, including all of the statistical analysis and display-enhancement programs. The CDF data can also be plotted as a map, in the form of contours for scalars, or barbs, arrows, or streamlines for winds and other derived vector fields using the program GEMPLOT. The third type of display for gridded data is to plot a X/Y time series at a particular point or points using the program TIMENV. If the user plans to process many time periods or do time-intensive computations (such as Ekman upwelling), it is suggested he first use the program ASCENV to create ASCII files for each time range in a batch mode, and then input the ASCII files to one of the programs ENVIMG or GEMPLOT. (ASCII files input to TIMENV must be created and saved by TIMENV.)

Much of the CDF archive is mass-stored on write-one-read-many (WORM) 12-inch platters for instant access from the Laboratory for Hydrospheric Processes' VAX cluster at the Oceans Computing Facility (OCF). This archive contains a decade or more of many types of wind datasets, including those from major forecast centers and experiments such as Fleet Numerical Oceanography Center (FNOC), the European Centre for Medium Range Weather Forecasting (ECMWF), and the First GARP Global Experiment (FGGE), as well as various climatologies, trimmed groups from the Comprehensive Ocean-Atmosphere Data Set (COADS), and sea-surface temperatures (SSTs) from NOAA's Climate Analysis Center (CAC), just to name a few examples. Wind fields can be used to derive fields such as Ekman upwelling, Ekman transport, surface stress, energy dissipation, Ekman depth, divergence and Sverdrup transport.

SEAPAK also can convert ungridded datasets, including those in the National Ocean Data Center (NODC) format and those from experiments such as SEQUAL/FOCAL and the Genesis of Atlantic Lows (GALE) experiment, to the VAX/VMS indexed file format so that they can be readily queried by key fields defined at the time of creation. For example, the program IXNODCSD converts NODC station data to an indexed file. Other indexing programs also begin with the prefix "IX". The query and listing is handled by programs

beginning with "RD", such as RDNODCSD for reading the NODC station data.

The program ASC2GEM handles the conversion of the ungridded data listings, which cover many types of measurements including drifters, conductivity/salinity/temperature vs. depth (C/STD), expendable bathythermographs (XBT), pressure gauge, station data and current meter data, to forms recognizable by other packages used for plotting, including Golden Software's Surfer and Grapher for the IBM PC environment, or the General Meteorological Package (GEMPAK) of the Laboratory's Severe Storm Branch (desJardins et al., 1988). These packages are used to display sections, vertical profiles, maps, and grids created through objective analysis procedures.

This section presents sample scenarios for utilizing SEAPAK's environmental data module to create the types of output described above. These scenarios represent some typical types of processing, but are not meant to be comprehensive. Many other variations are possible, depending on the data set and the user's application. The program sequence to produce each desired output is presented. Further detail on each program's overall operation and the individual parameters are presented later in the program sections of this manual.

I. GRIDDED DATA SCENARIOS

EXAMPLE 1: Generate pseudocolored seasonal mean gridded images of Ekman upwelling from FGGE data located on a SONY WORM platter, for a one-year period.

Approach: Since computations of upwelling can be lengthy, depending on the grid size, ASCII files with the gridded means for each season will be created in a batch mode. The data maximum and minimum over the four seasonal files will be found, so the output images can have a common gray level scaling. The imaging program will then be run from these ASCII files. Lastly, the pseudo-coloring program will be run on the images.

Specific Steps:

1. Load the SONY WORM platter containing the FGGE winds to either the lower or upper WORM drives, device names LDB0: and LDB1: on Diatom. Be sure the label describing the FGGE datasets is facing up. Push the platter gently into the drive and it will eventually drop in, similar to a tape being loaded into a VCR.
2. Run ASCENV for each season--this MUST be done from Diatom. Specify start and end dates for each season sequentially in the TAE parameter DATE. Specify INCREM=12 to denote that the input data are sampled at 12-hour intervals; the latitude/longitude limits in parameters LAT and LON; DATYP="CDF" so that the FGGE data are read from the CDF files; MEANPLT=1 so that a single grid representing the seasonal mean is produced; the default

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value for SPACING=(1,1) to cause every point in the latitude and longitude directions within the specified limits to be used; CDFNAM as a chronological list of all of the FGGE CDF's needed for the year (all present on a WORM optical platter at the OCF), e.g., OWINDS0:FGGE_DEC78 through FGGE_NOV79 if the platter is loaded in LDB0:, or OWINDS1:FGGE_DEC78 through FGGE_NOV79 if the platter is loaded in LDB1:; CDFPRM=("EKM", "WIND_U", "WIND_V") for total Ekman upwelling derived from the zonal and meridional wind components; LEVTYP="NONE" to indicate that there is only one level (which happens to be 1000 millibars) in the FGGE data so that no searching through levels will be necessary. Specifying LANDMASK="Y" will enable land masking so that Ekman upwelling is not calculated over land. By specifying DEST="F" and a value for FILENAME, the ASCII files will be saved to disk. Specify SONY=0 or 1, depending on whether the optical disk is loaded in DIATOM::LDB0 or DIATOM::LDB1 (the lower and upper WORM drives at the OCF, respectively). This will cause the system to mount the appropriate optical drive on the system before reading the FGGE data. Specify TYPE=2 so that the 1000 mb winds are treated like surface winds (i.e. non-geostrophic) and no corrections are applied to them as would be done to geostrophic winds used in computing surface stress. For METHOD, a value of 1 is suggested to use a technique developed in the literature by Large and Pond (1981) for deriving drag coefficients used in the surface stress calculations (used ultimately to derive upwelling) as a function of surface wind speed. All other parameters not mentioned may be left as their default values of "null". When all the parameters are input, you can type "save" to save the inputs to a file called ASCENV.PAR which can later be recalled with the command "restore". Next, at the TAE command line type "run |runtype=batch|" to submit the job to the VMS batch system. The job should be submitted as an overnight run since it will take many hours to complete. The output should consist of versions 1 to 4 of the file FILENAME, containing, respectively, the winter, spring, summer and fall upwelling means.

3. Run ASCFUNC with the four filenames of the ASCII files created in step 1 (parameter ASCFIL). Specify FUNC=4 and ASCFLG=0, as well as a dummy name for UTFIL. All other parameters can be left as their defaults (null). This program will output a line giving the maximum and minimum data values over the four files. It may also be run in batch mode.
4. Run ENVIMG (subcommand -ASC) using the four seasonal ASCII files. CORNERS can be left as the default to produce 512x512 images or changed to produce images covering a smaller portion of the screen. Specifying INTERP=1 will use the relatively quick bi-linear interpolation method for generating the image, rather than the slower spline. INFILE will contain the names of the seasonal ASCII files, in any order (be sure to include

the version numbers), while FILENAME will be the image equivalents of these four files. For MIN_DATA and MAX_DATA, enter the values obtained by ASCFUNC in step 3 to display the full range of data. Enter corresponding values for MIN_GREY (gray level for MIN_DATA) and MAX_GREY (gray level for MAX_DATA). You can then type "save" to create ENVIMG.PAR with your parameter inputs, and then "run|runtype=batch" to submit the job to the batch queue. The output image is created by interpolating 80x80 point portions of the input grid to the output image area; the number of portions depends on the area covered in the ASCII file.

5. Run IMAGE to display each of the images into a different channel on the IIS Model 75.
6. Run PAINT to pseudocolor one of the images after specifying the CHANNEL where the image is located in the IIS refresh memory. The LUT can be saved to disk to use with the other images as well.

EXAMPLE 2: Generate a one-year smoothed time series of zonal wind, taken from a FNOC CDF. Plot one value per day.

Approach: First find the mnemonic name of the variable for zonal wind within the CDF. Run the time series program, specifying the name of the CDF and the mnemonic in this data set for zonal wind. Since smoothing is requested, values at the data collection frequency (12 hours) will be averaged using 00Z, 1200Z, and 2400Z values to produce the daily mean value. This is equivalent to smoothing using a three-point running mean and subsampling every other point.

Specific Steps:

1. Load the SONY WORM platter containing the FNOC winds to either the lower or upper WORM drives, device names LDB0: and LDB1: on Diatom. Be sure the label describing the FNOC datasets is facing up. Push the platter gently into the drive and it will eventually drop in, similar to a tape being loaded into a VCR.
2. Run CDFLST, specifying the name of one of the FNOC CDF's on the SONY WORM platter in CDFNAM. The mnemonic should be the same in each CDF if there are more than one. Be sure to preface the name with "OWINDS0:" or "OWINDS1:" for platters loaded into LDB0: or LDB1:, respectively. Select CHOICE=2 to list the CDF mnemonic names, and SONY=0 or 1 to denote which SONY drive is holding the winds platter. Look for the mnemonic representing zonal wind. (Descriptions of each mnemonic are listed as well.) We'll assume it is "UWIND."
3. Run TIMENV, specifying PLOTS=30 (CDF). Also specify MODE depending on the graphics device to be used for the plots,

4 ENVIRONMENTAL DATA PROCESSING SCENARIOS

DATES for the starting and ending times for the one-year period, INCREM with a value 100 (one value per day), LAT and LON for the latitude/longitude location of the time series, SMOOTH="Y" to denote smoothing, RUNTYPE="A" for an attended run, and SONY=0 or 1 to denote which WORM drive contains the winds platter. When the dynamic screen for CHOICE appears, specify choice 5 to draw the plot, then values for CDFNAM (CDF name), and PARAM="UWIND" (mnemonic for zonal wind). LEVTYP should be set to "NONE" to denote data at a single atmospheric level. The user may retain the default for PTITLE (plot title) or change it. The same is true for MIN_DATA and MAX_DATA (Y-axis extreme values). Type "save" to create TIMENV.PAR with the parameter settings if desired, and "run" to generate the plot to the screen or an HPGL file if plotter output has been requested. Next, run with CHOICE=7 to exit TIMENV and to send HP.PLT containing the HPGL commands to the HP 7550 plotter queue if MODE=5 initially.

EXAMPLE 3: Generate a mean streamline map for March 1979 for the North Atlantic. Preview the output on a Tektronix-compatible terminal and then obtain an HP 7550A plot of this.

Approach: Run the environmental mapping program. Means will be computed based on 12-hourly FGGE data spacing. The mean streamlines and a map background will be drawn in separate steps by the program. Journaling will be enabled in order to capture commands entered through the TAE interface. The journal file will be "replayed" after program termination to create the HP hard copy.

Specific Steps:

1. Load the SONY WORM platter containing the FGGE winds to either the lower or upper WORM drives, device names LDB0: and LDB1: on Diatom. Be sure the label describing the FGGE datasets is facing up. Push the platter gently into the drive and it will eventually drop in, similar to a tape being loaded into a VCR.
2. Run the program GEMPLOT, specifying MODE=3 for the Color Trend or other Tektronix-compatible terminal, DATTYP="CDF" to indicate FGGE data stored as CDF's, and SONY=0 or 1 for a platter loaded into LDB0: or LDB1:, respectively. At the various dynamic tutors, enter CDFNAM="OWINDS0:FGGE_MAR79" or "OWINDS1:FGGE_MAR79" for a platter loaded in either LDB0: or LDB1:, DATE=(79030100,79040100), LAT=(0.,60.), LON=(-75.,-5.), INCREM=12 to read data at 12-hour intervals, and a value for PROJ (projection). For the dynamic tutor CHOICE, specify a value of 16 to enable journaling, and then a FILENAME for the journal file. All subsequent keystrokes, until journal is set off with CHOICE=17 or the program ends, will be saved. Specify CHOICE=5 to request vectors. When the next dynamic screen appears, specify MEANPLT=1 to compute the mean for the month every 12 hours, default SPACING of (1,1) to use every FGGE grid

point in latitude and longitude, and LANDMASK="N" to draw the streamlines over land. Then specify PARAM=("STREAM","WIND_U","WIND_V") for streamlines using the u and v wind components. The streamlines will then appear on the graphics screen after a short delay to read in the data. If you plan to create other graphics in this program, set journal off with CHOICE=17; otherwise you can just exit the program. CHOICE=3 should always be used in order to properly terminate the GEMPLT subprocess which is active during the program.

2. Run TOHP, specifying the journal file created in step 1, and an output journal file name. This will rerun your session from step 1, but output will be sent to the HP 7550A plotter. Note that any values for COLOR used on the Tektronix-compatible terminal correspond to pen numbers loaded in the carousel on the HP 7550A. If this is the only plot you plan to run, put the plotter in manual loading mode. In this way, you will have time to adjust the pen or paper types before the plot begins and to restore the initial configuration for subsequent users.

EXAMPLE 4: Generate a bathymetry image. Select the region from a global overview image. Contour the coastlines and bathymetry values of 1000 and 5000 meters. Fill in the area between 1000 and 5000 meters.

Approach: Run the environmental imaging program, specifying selection of a region from a global overview. Use the NORDA Digital Bathymetry Data Base. Note the scaling between depth and gray shade on the output image. Compute the gray shade corresponding to depths of 1000 and 5000 meters. Blotch between contours, using the gray level contouring program.

Specific Steps:

1. Tutor ENVIMG, subcommand -IIS, by typing "T ENVIMG-IIS". Specify MODE=2 to select a region from an overview image, GLBCHN=1 to reserve Model 75 channel 1 for the overview, DATTYP="NORDA" to ingest bathymetry data, DATE and INCREM both null since they do not apply to these data. CORNERS can be left as the default to produce 512x512 images, or changed to produce images covering a smaller portion of the screen. SONY can be left null since the bathymetry data are on-line. Type "run" and the button menu for ENVIMG will be dropped to the background channel. It can be made visible by pressing on the IIS foot pedal. Press a <CR> when instructed, to drop the global overview. You can then specify the pixel and line size for the regional box to create, and the IIS Model 75 graphics planes for marking and displaying the rectangle if desired (parameters SIZE, GPLANE, MARK). Use the trackball to move the box around the overview image and the trackball menu to change the size or graphics plane parameters as needed. When the box is positioned properly, press trackball button F3 to print the

box boundaries to your terminal and button A3 to generate the bathymetry image for this region. A series of messages indicating the progress of the program will appear on the terminal. A dynamic tutor will list the data minimum/maximum and prompt for the gray scaling and the land gray value as well as the interpolation type. By default, the full data range is displayed over the full gray range 0 to 255. Any of the parameters can be changed. All values greater than MAX_DATA will be assigned to MAX_GREY, and all values less than MIN_DATA will be assigned to MIN_GREY. A gray value for land (LANDGRY) should be specified and the interpolation method INTERP (bi-linear or cubic spline--bi-linear will run faster) should be indicated. The output image will be the size specified by CORNERS. Compute the gray shades corresponding to depths 1000 and 5000 meters from the image scaling. Use button B3 to save the image to disk.

2. Run CONTOUR. Specify PLANE for the initial contour graphics plane, BLANK="Y" if pre-existing graphics need to be erased, and MASKVAL=-1 to include all gray levels in the contours. (Masking can be used in areas of sharp gray level contrast to prevent proliferation of contours.) Press the IIS button C1 to add contours to the image. Choose MODE=1 to add contours only, ADDPLN=(1,2,3) to add contours to planes 1, 2, and 3 at gray level 0 in addition to the gray levels corresponding to 1000 and 5000 meter depths in ADDBRK, and MASKVAL=-1. Three contours will then be created on the image. Next, create the blotch by pressing button D1, specifying a plane to contain the blotch in BLPLN, MODE=2 to blotch between contours, and CONTS equal to the gray shades for 1000 and 5000 meters. Button D3 may be used to save the graphics to disk.

EXAMPLE 5: Plot the locations of stations from an NODC current meter data file with FGGE data of the North Atlantic region for the years 1978 and 1979.

Approach: Create an ASCII file using a data selection program for current meter data. Use this ASCII file as input into a second program which plots the locations on an image loaded on the IIS Model 75.

Specific Steps:

1. Run RDNCMDBA, specifying the spatial and temporal limits, depth, sort flag, and filename of the output ASCII file. Possible inputs are (-20,70) for LAT, (-78,12) for LON, (780101,791231) for TDATE, default for DEPTH (0 to 6000 meters), SFLAG=3 (sort output by date), INFILE="CUR_DATA: NC_FG_MD.DAT", and LISTFILE="NATL.ASC". OUTFILE, MFLAG and DSPSTEP can all be left null since only a list of the stations, not the actual stations, are needed. After a moment or two, the file NATL.ASC will contain the list of stations.

2. Run PLOTLOC, specifying LISTFILE with the ASCII file name, SKIP_LIN=3 for the current meter file format, DATA_LIN=0 to read to end-of-file, SUBSAMPL=1 to read all input points, COLUMN=(9,0,16,0) to specify start columns for latitude and longitude, WIDTH=(6,6,7,7) to specify widths for latitude and longitude fields, DECIMAL=(2,2) for the number of decimal places for latitude and longitude, WINDOW=(1,1,512,512) to define the output window to be the entire image, BORDER="NO" to suppress a border around the image window, PLANE=(3,3,3,3) to draw points, connecting lines, borders and labels in green on the Model 75, CHARACTER="+" to plot "plus" signs at the station locations, CONNECT="NO" so points are not connected with a line, LABEL=" " to suppress labelling the points, LAB_OFF=(0,0) since labels are not being drawn, and DISP_MSG=2 to display progress messages. The program will read the ASCII file and mark the station locations on the image.

II. UNGRIDDED DATA SCENARIOS

Before running any of the examples which follow, the user is assumed to have created ASCII files in either GEMPAK sounding format (for creating depth profiles or horizontal maps/grids in Examples 1 and 3) or surface format (for creating cross sections in Example 2).

EXAMPLE 1: Generate a plot of all observed temperature profiles crossing the oceanic gyre just off the coast of Charleston, SC, and collected on November 1, 1979, by the Skidaway Institute for Oceanography.

Approach: Ingest the data with the Skidaway listing program. Convert the data listing to GEMPAK4 binary sounding file format. Create the plot with one of the applications from the GEMPAK menu.

Specific Steps:

1. Run program RDSKDBA to create a data listing with the observed temperature data. Specify LAT=(32.38,33.03), LON=(-78.2, -77.6), DATE=(791101,791101), SFLAG=1 to sort by latitude, INFILE="HYD_DATA:SKD_SA.DAT", LISTFILE="SKDWAY.LIS", OUTFILE="SKDWAY.ASC", DEPTH=(0,500), OBSFLAG=(1,1,0,0,0,0,0,0) to list only the temperature data. Type "run" to run interactively or "run|runtype=batch" to run in a batch mode.
2. Run program ASC2GEM to convert SKDWAY.ASC to a form GEMPAK can recognize. Specify INFIL="SKDWAY.ASC", OUTFIL="SKDWAY_G4.ASC" to indicate that it will be in GEMPAK4 format, TYPE=1 to indicate that sounding format is needed, PRMSEL="A" to convert all data columns in the INFIL (in this case, only temperature), BLANK=(null) since this is only used for conversions to PC Surfer, TIME=(null) since TYPE=1, and ID_STN1 as the default

since TYPE=1. Type "run" to run interactively or "run|runtype=batch|" to run in a batch mode.

3. Type "SWITCHG" from SEAPAK command mode in order to run GEMPAK applications. The command prompt will return.
4. Enter the GEMPAK version 4 subsystem directly from step 3 in the SEAPAK menu if you wish to view it. It can be accessed from any OCF. Your account must have a subprocess quota set to at least 4 to use it, due to various subprocesses created by the TAE interface and GEMPAK itself.
5. Run GEMPAK4 program SNEDIT. This will be used for creating a GEMPAK4 format binary sounding file, and then loading this file with the ASCII data output by SEAPAK's ASC2GEM. The following should be noted about the input parameters to SNEDIT:
 - a. SNEFIL - The edit file name. Input the name of the ASCII file specified as OUTFIL from program ASC2GEM, SKDWAY_G4.ASC. (This should have been created using TYPE=1 in ASC2GEM.)
 - b. SNFILE - The output file (GEMPAK4 format upper air file) name. The convention normally used for upper air binary files is to use the same name as the edit file but with a filetype of .SND. In this case the name would be SKDWAY_G4.SND.
 - c. TIMSTN - Total number of times and stations expected in the upper air binary file SNFILE. Put the number of unique times processed by ASC2GEM before the slash (or a sufficiently large number if the exact number is not known). After the slash, specify the total number of unique profiles expected to be added to the sounding file, over all times. The first time you run SNEDIT (i.e. when the sounding file is created for the first time), the second part of TIMSTN must include the number of profiles initially loaded plus the number of any additional profiles which may be added later (space is reserved for the expected total number of profiles, at data set creation). For later runs (i.e. after the sounding file has already been created and you are simply modifying data in the file), the value of TIMSTN is unimportant. For example, for this exercise a value of TIMSTN="20/20" would reserve space for 20 times and 20 profiles, more than enough to cover the 10 unique times and 10 unique profiles which appear in SKDWAY.ASC when RDSKDBA is run, plus any additional profiles which might be added later.
6. Run GEMPAK4 program SNPROF. This is used for plotting the vertical profile(s) for up to two parameters, to any GEMPAK-supported device, for each call to SNPROF. By setting CLEAR=

"NO" and setting a common scale with parameter XAXIS, multiple profiles can be plotted on the same axes with multiple invocations of SNPROF. The following should be noted about the parameters for program SNPROF (specific inputs are provided for running the current scenario):

- a. SNFILE - Specify "SKDWAY_G4.SND" for the upper air binary file name.
- b. DATTIM - Specify a value of "ALL" since for this case it will be easiest to query the profiles by station number (in parameter AREA) which is unique and just a sequence number.
- c. AREA - Specify "DSET" to indicate that all profiles in the data set should be included.
- d. PARM1 - Specify "TEMP/2" to plot the temperature profile in color index 2, using the default line type and line width
- e. PARM2 - May be left blank since only one parameter, temperature, is available in this example.
- f. PTYPE - Specifies the plot type. For oceanographic profiles specify PTYPE="LIN" (linear in the vertical).
- g. VCOORD - Specifies the vertical coordinate parameter name in the sounding file. ASC2GEM writes the depths into parameter HGHT so this name should always be specified for VCOORD.
- h. STINDEX - Should be left blank since this is the stability index for atmospheric soundings.
- i. STNCOL - Should be left blank since this is the plot color for the stability index for atmospheric soundings.
- j. WIND - This is the symbol to use for winds. Set WIND="0" since winds will not be plotted for the depth profiles.
- k. WINPOS - This may be left blank since no winds will be plotted in the current scenario.
- l. MARKER - This may be set to 0 if no markers along the XBT profile are desired, otherwise any color index 1-7 is appropriate.
- m. BORDER - This should be set to any color 1-7 so that a background with the height and temperature scale axes will be drawn.
- n. TITLE - This is the title color, line and text separated by slashes. To suppress the title, set TITLE="0". To put a

sample title, use an input such as "5/-1/TEST TITLE" to write the title one line from the bottom.

- o. DEVICE - This is the graphics device for plotted output. At the OCF, GEMPAK-supported devices present include a HP 7550A plotter (device "HP"), color Tektronix 4105-compatible terminal (device "CT"), DEC VT240 (device "V2"), and IIS Model 75 (device "II"). Note that if you are sending output to device HP, you should invoke GEMPAK4 program GPOUT to send the HP-GL file (named HP.PLT in the current directory and containing the HPGL plot instructions) to the plot queue HPLQTQ after exiting SNPROF.
- p. YAXIS - These are the Y-axis limits (i.e. depth) for the output. Since the GEMPAK4 defaults are 0 to 20,000 for the minimum and maxima on this axis and ASC2GEM always writes the depths as negative numbers, a value for YAXIS should be entered by the user. A typical input for YAXIS might be "0/-500/50", meaning that the top of the Y-axis is depth 0, the bottom (origin) is at 500 meters depth, and an interval of 50 meters will appear on the plot.
- q. XAXIS - These are the X-axis limits which depend on the profile parameter being plotted. Defaults will be computed from the dataset if XAXIS is left blank, or the user can provide his own max/min/increment if desired. For the current example, a value of "8/28/4" is suggested to cover the range over the 10 profiles.
- r. FILTER - A value of "NO" is suggested here since it refers to whether wind barbs will be filtered. (None are plotted in this example.)
- s. CLEAR - A value of "NO" should be provided so that the screen will not be cleared between plots. In this way all 10 plots will appear on the same set of axes.
- t. PANEL - A value of "0" should be supplied so the graphics will cover the entire limits of the output device and no border will be drawn around it.
- u. TEXT - A value of "1" will use standard size text on the graphics screen for the title and labels.
- v. THTALN - This is the plot color for potential temperature lines. Since these do not apply to oceanographic profiles, set THTALN="0".
- w. THTELN - This is the plot color for equivalent potential temperature lines. Since these do not apply to oceanographic profiles, set THTELN="0".

- x. MIXRLN - This is the plot color for mixing ratio lines. Since these do not apply to oceanographic profiles, set MIXRLN="0".

NOTE: An alternative approach is to have each profile appear in a different color on the plot. To do this requires changing the PARM1 color and AREA parameter to draw one plot at a time. That is, specify AREA=@1 and PARM1="TEMP/1" for the first run, AREA=@2 and PARM1="TEMP/2" for the second, etc. Also note that a maximum of 3 time titles, containing the time and corresponding station ID, will appear at the top of the plot. If more than 3 plots are requested within a given run, title 4 will overwrite title 1, title 5 will overwrite title 2, etc. If more sophisticated annotation is desired, SNPROF can be run specifying DEVICE="II" (IIS model 75) and the SEAPAK program ANNOTATE may be used.

EXAMPLE 2: Create a vertical cross section in PC-Surfer on a IBM PC/compatible using the 10 profiles from Example 1.

Approach: Convert file SKDWAY_G4.ASC to a columnar form directly importable into Surfer. Copy the file over a network link to the PC and work with it in Surfer.

Specific Steps:

1. Run GEMPAK4 program SNLIST. This will create a listing of all profiles ingested in Example 1. Note the following about its inputs:
 - a. SNFILE - Specify "SKDWAY_G4.SND" for the input (GEMPAK4 binary upper air) file name.
 - b. AREA - Specify "DSET" (entire dataset) so all profiles are listed.
 - c. DATTIM - Specify "ALL" (all times) so all profiles are listed.
 - d. SNPARM - Specify "TMPC" to list the Celsius temperatures.
 - e. STNDEX - Specify a value of " " since no stability index calculations will be done.
 - f. LEVELS - Specify "ALL" to retain the original vertical resolution of the data.
 - g. VCOORD - Specify "HGHT" to indicate the mnemonic of the vertical coordinate.
 - h. OUTPUT - Specify "F" so the output file SNLIST.FIL is created with the profile data.

Type "run" to run interactively.

2. Type "SWITCHS" to switch back to running SEAPAK programs.
3. Run SEAPAK program SURFSCT. This will convert GEMPAK's SNLIST output ASCII file(s) to a form Surfer can recognize. Note the following about its inputs:
 - a. INASC - Specify "SNLIST.FIL" for the input (GEMPAK4 format) file name.
 - b. OUTASC - Specify "SKDWAY_S.ASC" for the output (Surfer format) file name.
4. Copy SKDWAY_S.ASC to the PC system containing Surfer using Smarterm, Kermit or Network File Transfer (NFT) of DECNET-DOS.
5. Run the GRID program from within Surfer, passing it a filespec of "SURFER_S.ASC" from whatever directory it was copied to. Columns 2, 3 and 4 represent X (distance), Y (depth) and Z (temperature), respectively. After creating the binary grid, run the TOPO module in Surfer to create the cross section.

NOTE: An alternative approach is to replace steps 1-3 with the running of SEAPAK program ASC2GEM, similar to step 2 in Example 1 above. In this case specifying TYPE=4 in ASC2GEM will create the Surfer columnar format directly. The X, Y and Z columns for distance, depth and temperature will be columns 1, 3 and 4. ASC2GEM also allows you, in parameter BLANK, to request a Surfer blanking file for blanking out land in the section during the gridding step, and/or a Surfer boundary file for plotting the bottom contour when plotting the section with TOPO.

EXAMPLE 2A: Create a vertical cross section using GEMPAK4 and the 10 profiles from Example 1.

Approach: Since GEMPAK's cross section program only supports potential temperature and related quantities as the plotting parameter, the surface programs will be used to emulate the look of a cross section, with the advantage that any parameter can be plotted. The basic method involves substituting depth and sounding sequence number in the cross section for the latitude and longitude which would normally appear in the Y and X directions on a GEMPAK grid plot. The grid contour plot is obtained by running the GEMPAK objective analysis program on the ungridded surface data. In the ungridded surface file, each depth of each profile is treated as a separate "station".

Specific Steps:

1. Run program ASC2GEM, similar to step 2 of Example 1, to convert SKDWAY.ASC to a form GEMPAK can recognize. Specify INFIL=

"SKDWAY.ASC", OUTFIL="SKDWAY_G4.ASC" to indicate that it will be in GEMPAK4 format, TYPE=2 to indicate that surface format is needed, PRMSEL="A" to convert all data columns in the INFIL (in this case, only temperature), BLANK=(null) since this is only used for conversions to PC Surfer, any value for TIME since TYPE=2--i.e. 900815/0000, and ID_STN1 as the default since TYPE=2. Type "run" to run interactively or "run|runtype=batch|" to run in a batch mode.

2. Run program SFCFIL. This creates an empty binary surface file containing the depths ("stations") and information on the data parameters to be loaded. The following should be noted about the parameters to SFCFIL:
 - a. SFOUTF - This is the name of the output surface binary file. Specify the name "SKDWAY.SFC".
 - b. SFPRMF - This is the name of the parameter "packing" file containing information on the data parameters including their minimum and maximum values and the number of places after the decimal point to retain. A comprehensive packing file, containing all of the parameters referenced by the hydrographic data programs, has been written and is called HYDRO.PCK in directory CDF\$DAT. This should be specified for SFPRMP.
 - c. STNFIL - This is the "station" list file which, for lat/lon mapping applications, allows GEMPAK to navigate properly by providing the latitude, longitude and elevation of each station. For oceanographic applications, the station list file contains a line for each depth in each sounding and the corresponding sounding sequence number. Setting TYPE=2 in ASC2GEM will result in the creation of a station list file with the same name as OUTFIL with "_stns" appended to the filetype. In this case specify "SKDWAY_G4.ASC_STNS".
 - d. SHIPFL - This is the ship file flag, and should be set to "NO".
 - e. TIMSTN - Total number of times and additional "stations" expected in the surface binary file SFOUTF. Put the number of unique times processed by ASC2GEM, before the slash (or a sufficiently large number if the exact number is not known). After the slash, specify the total number of additional levels ("stations") which may be added later to supplement those in the original 10 profiles. (Space is reserved at dataset creation for the expected total number of levels.) For example, for this exercise a value of TIMSTN="20/100" would reserve space for 20 times and 100 additional levels, more than enough to cover the 10 unique times which appear in SKDWAY.ASC when RDSKDBA was run.

Run the program by typing "run" and the message "The file has been created" will appear if everything has gone normally.

3. Run program SFEDIT - This is used to load the TYPE=2 ASCII file from ASC2GEM into the binary file created in step 1. The following should be noted about its inputs:
 - a. SFEFIL - The file corresponding to OUTFIL in ASC2GEM ("SKDWAY_G4.ASC") should be specified.
 - b. SFFILE - Specify "SKDWAY.SFC" to denote the binary surface format file.

Run the program by typing "run". The binary surface file is now loaded with the "surface" data to be used in generating a cross section.

4. Run the program OAGRID. This creates an empty GEMPAK4 grid file, which will ultimately contain objectively analyzed data for the various levels of the vertical profiles to be used in the cross section. The following should be noted about its inputs:
 - a. GDFILE - This is the name of the output grid file. A value of "SKDWAY.GRD" is suggested.
 - b. DELTAN - This is the average "station" (depth) spacing expressed in units of degrees of latitude and used by the Barnes objective analysis for computing weights when performing the interpolation. In the station list file used for hydrographic data plotting, depth replaces latitude used in the atmospheric station lists. The actual depths are divided by 100 in the list file so that the result never exceeds the maximum latitude value of 90. Thus hydrographic data to a maximum depth of 9000 meters can be plotted. Finding the best value for DELTAN may take some trial and error. The best value will yield data at all points on the grid. (I.e., none missing when the objective analysis is done.) A value of DELTAN of 2.5 has been found to give good results for a cross section with 11 profiles and a depth of 500 meters, so it is suggested that 2.5 be used when running this test.
 - c. DELTAX - This is the spacing in the X direction for the output grid. In the cross section, the X direction represents profile sequence number, hence a value of 1.0 is recommended because it will cause a grid point to be created for each profile.
 - d. DELTAY - This is the spacing in the Y direction for the output grid. In the cross section, the Y direction represents depth. To break the Y axis into 10 segments, divide

the absolute value of the greatest depth by 1000. (Recall that the depth is divided by 100 for presentation purposes.) For example, if the greatest depth is -500, set DELTAY=0.5 to get 10 segments. For this example, DELTAY=0.5 would be optimum since the original ingest was for depths of 0-500 meters.

- e. GRDAREA - This is the latitude/longitude (or their analog) area for the grid. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude", or for the hydrographic profiles, "greatest depth/100; minimum profile sequence number; least depth/100; maximum profile sequence number". For this example, specify GRDAREA="-5;1;0;10" for the 10-profile cross section going from 0 to 500 meters in depth.
- f. EXTEND - The default of "2;2;2;2" will be fine for this test. This means the grid will be extended by two points on every side for the first pass of the Barnes objective analysis.
- g. DTAAREA - The objective analysis data area can be specified as " ", which means it will default to the extend area.
- h. SOURCE - This is the type of data to be objectively analyzed, surface or sounding. For hydrographic cross sections as in this example, specify SOURCE="SF" (surface data). The parameter SFFILE will contain the name of the binary surface file created in step 1 above.
- i. SNFILE - This can be left blank since surface data are being objectively analyzed (specified in parameter SFFILE).
- j. SFFILE - Specify the name of the binary surface file, "SKDWAY.SFC".
- k. SNPARM - Can be left blank since surface data are being objectively analyzed (specified in parameter SFPARM).
- l. SFPARM - These are the names of the data parameters you wish to objectively analyze in preparation for generating a cross section. They are specified as a list separated by semi-colons and should be the same names used in parameter PARMS in ASC2GEM (i.e. SIGT, TEMP, IPHS). For this example, specify a value of "TEMP" for temperature.
- m. DATTIM - A value of "LAST" or "ALL" will give the same result since there is only a single time in the surface file, specified with parameter TIME when ASC2GEM was run in step 1.

- n. LEVELS - These are the levels to be found in the grid file. Since we are using surface data only, specify LEVELS="SFC".
 - o. MAXGRD - This is the maximum number of grids to allow in the grid file for allocation purposes. The default is 200. Keep in mind that each cross section is actually only a single grid, so the default should be quite adequate for most purposes, including this example.
5. Run program OABSFC. This will perform a Barnes objective analysis on the depth/sounding data to create gridded values. The following should be noted about the inputs:
- a. SFFILE - Specify the name of the binary surface file, "SKDWAY.SFC".
 - b. GDFILE - This is the name of the output grid file. A value of "SKDWAY.GRD" is suggested.
 - c. SFPARM - These are the names of the data parameters you wish to objectively analyze in preparation for generating a cross section. They are specified as a list separated by semi-colons and should be the same names used in parameter PARMS in ASC2GEM (i.e. SIGT, TEMP, IPHS). For this example, specify a value of "TEMP" for temperature.
 - d. DATTIM - Should always be set to either "LAST", since the surface format ASCII file created by ASC2GEM contains just one time--the time specified by parameter TIME when ASC2GEM was run.
 - e. AREA - Should normally be set to "DSET" to grid all of the data in the surface file. An area smaller than this can always be contoured in the next step if desired.
 - f. GAMMA - The default of 0.3 should be sufficient for this test.
 - g. SEARCH - This is the maximum distance that a station (level in this case) may be from a grid point in order to be used in the analysis for that point. The upper limit of 50 is suggested to be used for SEARCH.
 - h. NPASS - The default value of 2 is recommended for the number of passes over the data.

Type "run" to run the program. You will get a message that the data are being processed for your time, followed by the RMS temperature values for passes 1 and 2. The result is the creation of a grid named TEMP within the file SKDWAY.GRD.

6. Run the program GDCNTR. This is the final step and will actually create the cross section to the selected GEMPAK-supported device. The following notes refer to the program's parameter inputs:
 - a. GDATTIM - Specify "LAST" since only a single time is stored in the surface file.
 - b. GLEVEL - This is the vertical level parameter and should be entered as "0" since the data are treated as surface data.
 - c. GVCORD - This is the vertical coordinate and should be entered as "NONE" since the data are treated as surface data.
 - d. GFUNC - Specify a single parameter name from the list selected in parameter PARMS when running ASC2GEM and enclose it in quotes. In this case, the value would be "TEMP".
 - e. GDFILE - Specify the name of the binary grid file created in the previous step, "SKDWAY.GRD".
 - f. GAREA - This is the latitude/longitude (or their analog) area for the grid. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude", or for the hydrographic profiles, "greatest depth/100; minimum profile sequence number; least depth/100; maximum profile sequence number". For this example, specify GRDAREA="-5;1;0;10" for the 10-profile cross section going from 0 to 500 meters in depth.
 - g. CINT - This is the interval/minimum/maximum values for contouring. If you enter a "0" for CINT (this is suggested for this test), GDCNTR will compute 5-10 contour values (after first scaling the data using parameter SCALE) and ask you to accept these before drawing the cross section. Note that acceptance of the default in cases where there are bathymetry fill values (-9999.9) may result in all of the contours falling out of range of the real data. In this case the user should specify precise contours for the data, then run GDCNTR again (specifying CLEAR="NO" so the data contours are not erased) to contour the bathymetry if desired. To contour bathymetry, specify an interval of 0, and a minimum and maximum both the same and equal to a value intermediate between the smallest real data value and the bathymetry flag of -9999.9.
 - h. SCALE - The data to be plotted are multiplied by 10**SCALE. SCALE defaults to 0 if the user enters a number whose absolute value is greater than 20. Since the actual temperatures are stored in the grid, a value of 0 is the proper input for this scenario.

- i. COLORS - This is a list of colors, separated by semicolons, for the various contours. On the IIS terminal, this represents graphics plane numbers, and for all other devices the color indices, which depend on the device setup. To run this example, specify a value of "1;2;3;4;5;6;7" so that each contour will appear in a different color.
- j. MAP - This is the color for a background map. Since the hydrographic cross section is not actually on a latitude/longitude plane, the map should be suppressed by specifying a "0" for MAP.
- k. TITLE - This is the annotation line for the plot, to appear at the bottom of the screen or page, in the form "title color/device line number/text". A value of "0" can be entered to suppress the title. For this example enter a value "1/-1/TEMP. SECTION ACROSS GYRE" to write the title one line above the bottom of the device.
- l. DEVICE - For graphics device, enter the appropriate value, such as "CT" for the color Tektronix terminal or "II" for the IIS Model 75.
- m. PROJ - For the background map projection use the default since no map will be drawn. Any value is acceptable.
- n. PANEL - Enter a value of "0" since a full-screen cross section, with no border around it, is desirable for this case.
- o. CLEAR - Should be set to "YES" so that any graphics previously drawn to the screen is erased before creating the cross section.
- p. LINTYP - Set this to "1;2;3;4;5;6;7" to see each contour in a different GEMPAK line type, various solid and dashed patterns.
- q. LINWID - Set this to "1;2;3;4;5;6;7" to see each contour in a different GEMPAK line width. These are multipliers of the standard width.
- r. LINLBL - Inputting a value of "1" will cause every contour line to be labelled.
- s. TEXT - A value of "1" will cause the default text size to be used for the title and labels.

The contour will be drawn after typing "run" from the TAE prompt.

6a. You will also want to run the GEMPAK program GPLLLN to put axes in the depth and profile direction on the section. The inputs are as follows:

- a. LATINC - For the hydrographic section drawn within GEMPAK, this is actually the plotting increment for lines in the depth (Y axis) direction. A value of "1" will draw a horizontal line at 100 meter intervals on the section; a value of "5" will draw lines only for the 0 and 500 meter depths (providing top and bottom borders for the section).
- b. LONINC - For the hydrographic section drawn within GEMPAK, this is actually the plotting increment for lines in the profile (X axis) direction. A value of "1" will draw a vertical line at every profile on the section; a value of "10" will draw a line only for the 10th profile (providing a border on the right-hand side of the section).
- c. LBLFRQ - The line labelling frequency should be set to "1" to label every line that is drawn.
- d. LINE - A value of "1" will draw the axes in a solid line of color index or graphics plane 1.
- e. DEVICE - For graphics device, enter the appropriate value, such as "CT" for the color Tektronix terminal or "II" for the IIS Model 75.

The lines will be drawn after typing "run" from the TAE prompt.

6b. You may also wish to run SFLIST, the surface file list program, to dump out raw depth data from the surface file (before objective analysis). The following notes refer to its inputs:

- a. SFFILE - Specify "SKDWAY.SFC" to denote the binary surface format file.
- b. AREA - This is the latitude/longitude (or their analog) area for the file. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude", or for the hydrographic profiles, "greatest depth/100; minimum profile sequence number; least depth/100; maximum profile sequence number". For example, specifying AREA="-5;1;0;10" will print all the raw depth data for the 10-profile cross section from 0 to 500 meters in depth.
- c. DATTIM - These are the date/time limits for the data to be chosen. Use DATTIM="LAST" since all data are stored at a single time in the surface format.
- d. SFPARM - These are the names of the data parameters you wish to list. They are specified as a list separated by semi-

colons and should be the same names used in parameter PARMS in ASC2GEM (i.e. SIGT, TEMP, IPHS). For this scenario enter "TEMP" for temperature.

- e. OUTPUT - The output device can be specified as "T" for this example to type out the data to the screen.
 - f. IDNTYP - Use "STID" (station ID) to identify the stations from the surface station list. This list is created along with OUTFIL by ASC2GEM. It has the same name as OUTFIL with the suffix "_stns" appended to the filetype. In this case, the name is "SKDWAY_G4.ASC_STNS").
- 6c. You may also wish to run the program GDLIST, the grid listing program, to dump out the objectively analyzed values used in the plot or quantities computed from raw data in the grid file. The following should be noted about its inputs:
- a. GDATTIM - Specify "LAST" since only a single time is stored in the surface file.
 - b. GLEVEL - This is the vertical level parameter and should be entered as "0" since the data are treated as surface data.
 - c. GVCORD - This is the vertical coordinate and should be entered as "NONE" since the data are treated as surface data.
 - d. GFUNC - Specify a single parameter name from the list selected in parameter PARMS when running ASC2GEM and enclose it in quotes, or a tokenized string (as described in the help for GFUNC within GDLIST) referring to a diagnostic quantity to be computed from raw fields in the grid file. For this example, enter "TEMP" to list the temperatures.
 - e. GDFILE - Specify the name of the binary grid file "SKDWAY.GRD".
 - f. GAREA - This is the latitude/longitude (or their analog) area for the file. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude", or for the hydrographic profiles, "greatest depth/100; minimum profile sequence number; least depth/100; maximum profile sequence number". For example, specifying AREA="-5;1;0;10" will print all data on the depth/profile grid (section).
 - g. PROJ - For the background map projection take the default since no map will be drawn. Any value is acceptable, for example "MER" for Mercator.

- h. SCALE - The data to be plotted are multiplied by 10**SCALE. SCALE defaults to 0 if the user enters a number whose absolute value is greater than 20. Since the actual temperatures are stored in the grid, a value of 0 is the proper input for this scenario.
- i. OUTPUT - The output device can be specified as "T" for this example to type out the data to the screen.

After typing "run", the grid values will be listed to the screen.

- 6d. You may also wish to run the SEAPAK program BTHGRD to insert a bathymetry flag at points on the GEMPAK4 grid below the bottom depth for each profile along the X-axis of the grid. Run GDLIST as in step 5c above, this time specifying OUTPUT="F" to create a file named GDLIST.FIL. The following are suggested inputs for BTHGRD:
 - a. STNLST - This is the name "SKDWAY.LIS" specified in ASC2GEM, with the listing of Skidaway profile locations and times.
 - b. GRID - This is the input ASCII grid, named GDLIST.FIL.
 - c. OUTGRD - This is the output ASCII grid, which can be named SKDWAY_BLK.ASC to indicate that it has been blanked.

After typing "run," the updated ASCII file is SKDWAY_BLK.ASC. It can then be used in conjunction with GDEDIT to load the ASCII file into the binary format, and GDCNTR to limit contours so they are drawn only in regions above the ocean bottom.

EXAMPLE 3: Generate a horizontal map of the ungridded temperatures ingested in Example 1 for the 100 meter depth.

Approach: By specifying TYPE=3 in the SEAPAK program ASC2GEM, you can create a GEMPAK4 format sounding file where all the soundings are assigned the same time. This is necessary in order to view multiple soundings on the same horizontal map or grid. Obviously these soundings should have been collected over a time interval where the sampled data are not expected to change significantly in order for them to be compared on the same map. You can still plot or list profiles using GEMPAK4 on a TYPE=3 ASCII file, however you will be constrained to selecting the sounding(s) by lat/lon rather than time since time is assigned the same value for all. You can load a TYPE=3 file into a GEMPAK4 binary sounding file in a manner similar to that described above for TYPE=1 files and then run the GEMPAK4 sounding map program to plot values at a particular level or run the objective analysis program to grid the data. By gridding the data you can then contour them or use GEMPAK4's

diverse diagnostic functions to compute new quantities from the raw data.

Specific Steps:

1. Run the SEAPAK program ASC2GEM as described in ungridded Example 1, step 2 above, except specify TYPE=3 so that all profiles are given a common time to be specified in parameter TIME. (Any time will be fine.) The default for ID_STN1, a value of 1, will be sufficient.
2. Switch to GEMPAK operations by typing "SWITCHG" at the TAE prompt.
3. Run the GEMPAK4 program SNEDIT, as described in Example 1, step 5 above. Use the TYPE=3 file output from ASC2GEM (new version of "SKDWAY_G4.ASC") for parameter SNEFIL instead of the TYPE=1 file referred to there. Specify SNFILE="SKDWAY.SND2" so that the editing is not done into the TYPE=1 sounding file created previously.
4. Run the GEMPAK4 program SNMAP to plot all values at a particular level from the raw profiles on the same map background. The following should be noted about the inputs to SNMAP:
 - a. AREA - This is the latitude/longitude outline area for the profiles to be plotted. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude". All profiles falling within these bounds will be plotted. For this example, setting AREA="32.38;-78.2;33.03;-77.6" will plot all profiles along the section.
 - b. GAREA - This is the latitude/longitude area for the graphical output. Only profiles falling within these bounds will actually be displayed and others will not be displayed even if falling within the bounds of AREA. Use the specification "southern latitude; western longitude; northern latitude; eastern longitude". For this example, setting GAREA="32.38;-78.2;33.03;-77.6" will assure that the graphics area is the same as the data ingest area.
 - c. SNPARM - These are the names of the data parameters you wish to plot. They are specified as a list separated by semi-colons and should be the same names used in parameter PARMS in ASC2GEM (i.e. SIGT, TEMP, IPHS). In this case, specify "TEMP" for temperatures.
 - d. DATTIM - These are the date/time limits for the profiles to be chosen. Since all of the profiles have the same time assigned to them, you should use either this time explicitly (as specified in ASC2GEM's TIME parameter), or easier still, the string "LAST" for DATTIM.

- e. LEVELS - These are the levels at which data will be displayed. Normally you will use a value of "SFC" to signify depth=0 since this may be the only level in common amongst all of the profiles. If you specify a level explicitly, be sure to include a minus (-) sign in front of the value, since this is how they are stored in the GEMPAK files (i.e. -400 for 400 meter depth). Note that the designator "TOP", which is a valid input to LEVELS, actually represents the bottom, or greatest depth, when used with this hydrographic data. For this example, we have chosen a 100 meter depth, so enter LEVELS=-100.
- f. VCOORD - Should be set to "HGHT" for the hydrographic data.
- g. SNFILE - Specify a value of "SKDWAY.SND2" for the upper air file.
- h. COLORS - This is a list of colors, separated by semicolons, for the various fields to appear on the map. On the IIS terminal, this represents graphics plane numbers, and for all other devices the color indices, which depend on the device setup. To run this example, specify a value of "1" so that the temperatures will appear in color 1.
- i. WIND - Should always be set to "0" for the Skidaway data since there are no wind data to plot.
- j. MAP - This is the color for a background map. Since the hydrographic cross section is not actually on a latitude/longitude plane, the map should be suppressed by specifying a "0" for MAP.
- k. MARKER - This is the marker color/type/size/hardware flag parameter. A value of "1" is suggested to use a plus sign as a marker.
- l. TITLE - This is the annotation line for the plot, to appear at the bottom of the screen or page in the form "title color/device line number/text". A value of "0" can be entered to suppress the title. For this example enter a value "1/-1/TEMP. SECTION ACROSS GYRE" to write the title one line above the bottom of the device.
- m. CLEAR - This is the clear screen flag and should be entered as "YES" for this scenario in order to clear any pre-existing graphics from the display device before drawing the profile map.
- n. TEXT - This is the text size/font/hardware flag and can be set to "1" to use text of standard size.

- o. PANEL - A value of "0" should be used to indicate that the full graphics device should be used to display the profile map.
 - p. DEVICE - For graphics device, enter the appropriate value, such as "CT" for the color Tektronix terminal or "II" for the IIS Model 75.
 - q. PROJ - For the background map projection, use the default since no map will be drawn. Any allowable value may be specified.
 - r. SCALE - The data to be plotted are multiplied by 10**SCALE. SCALE defaults to 0 if the user enters a number whose absolute value is greater than 20. Since the actual temperatures are stored in the grid, a value of 0 is the proper input for this scenario.
 - s. FILTER - This flag enables the user to plot only a portion of the data in order to provide a cleaner plot. For this scenario, a value of "NO" is suggested since there are relatively little data and the user will probably want to view all profiles.
3. A horizontal grid file to hold objectively analyzed sounding data at a particular level or levels can be created with program OAGRID. Refer to Example 2A, step 4 above for details on the inputs. Note that the grid created in this case has longitude along the X-direction and latitude along the Y-direction. The inputs will vary slightly from Example 2A, step 4, as follows:
- a. LEVELS - Since these are profile data, a single level or group of levels may be explicitly given, or the designators "TOP" or "SFC" used to denote the greatest or shallowest depth in the profiles, respectively. To create a grid with just the data from a depth of 100 meters, specify LEVELS=-100.
 - b. DELTAN - Use the estimated station spacing in actual degrees latitude, without dividing by 100. You can also leave this blank and the program will suggest a DELTAN for you.
 - c. DELTAX, DELTAY - As with DELTAN, specify a value for grid spacing in the X and Y directions in actual degrees latitude.
 - d. SOURCE - Specify "SN" since these are sounding data.
 - e. SNFILE, SNPARM - Will replace their analogs SFFILE and SFPARM used for surface data. The values of SFFILE and SFPARM, if input, will be ignored if SOURCE="SN".

4. If step 3 is run to create a grid, OABSND should be run to perform a Barnes objective analysis of the sounding data. The following should be noted about the inputs to OABSND:
 - a. SNFILE - Specify the name of the binary surface file, "SKDWAY.SND2".
 - b. GDFILE - This is the name of the output grid file. A value of "SKDWAY.GRD" is suggested.
 - c. SNPARM - These are the names of the data parameters you wish to objectively analyze. These are specified as a list separated by semicolons and should be the same names used in parameter PARMS in ASC2GEM (i.e. SIGT, TEMP, IPHS). For this example, specify a value of "TEMP" for temperature.
 - d. STNDEX - Should be left blank since this is the stability index for atmospheric soundings.
 - e. AREA - Should normally be set to "DSET" to grid all of the data in the sounding file. An area smaller than this can always be contoured in the next step if desired.
 - f. LEVELS - Specify "-100" to objectively analyze the data at a depth of 100 meters.
 - g. VCOORD - Specifies the vertical coordinate parameter name in the sounding file. ASC2GEM writes the depths into parameter HGHT so this name should always be specified for VCOORD.
 - h. DATTIM - Should always be set to either "LAST" since the sounding format ASCII file created by ASC2GEM contains just one time--the time specified by parameter TIME when ASC2GEM was run.
 - i. GAMMA - Specify the recommended value of 0.3 for the convergence parameter.
 - j. SEARCH - This is the maximum distance that a station may be from a grid point in order to be used in the analysis for that point. The upper limit of 50 is suggested.
 - k. NPASS - The default value of 2 is recommended for the number of passes over the data.

Type "run" to run the program. You will get a message that the data are being processed for the specified time, followed by the RMS temperature values for passes 1 and 2. The result is the creation of a grid named TEMP within the file SKDWAY.GRD.

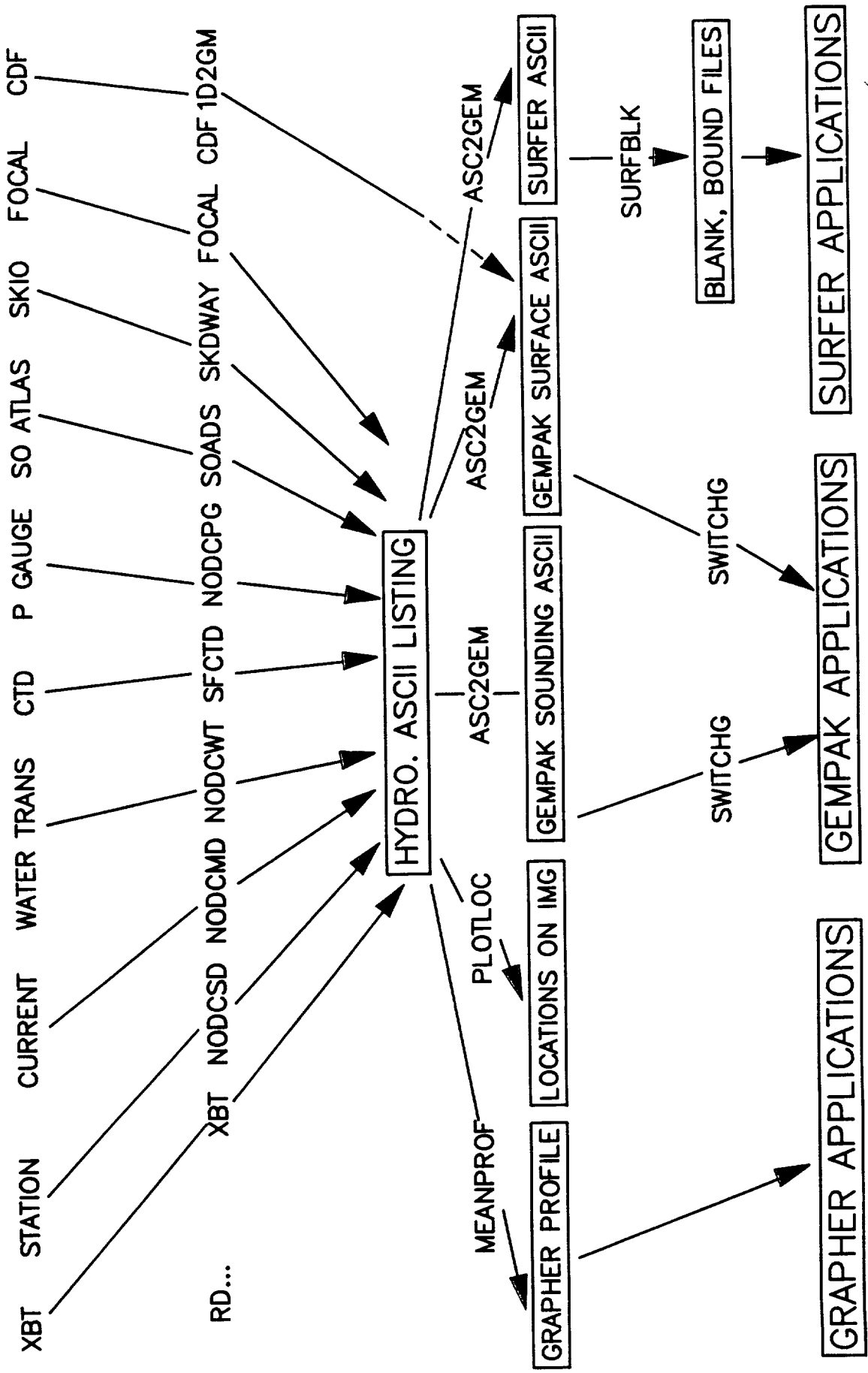
5. If a grid is created and objectively analyzed using steps 3 and 4, GEMPAK4 programs GDMAP, GDCNTR, GDLIST and GDDIAG, can be

used to write the grid values on a map, contour the values, list the values and create diagnostic grids, respectively. (See Example 2A, step 6 above.) The SEAPAK program GEMGRD can be used to either put land flags in the ASCII output of GDLIST so that contours generated will not extend over land areas, or to convert the ASCII file to a form compatible with the Surfer package for the IBM PC/compatible. If more than one level has been objectively analyzed, GDPROF can be used to draw a vertical profile at particular grid points.

[illegible]

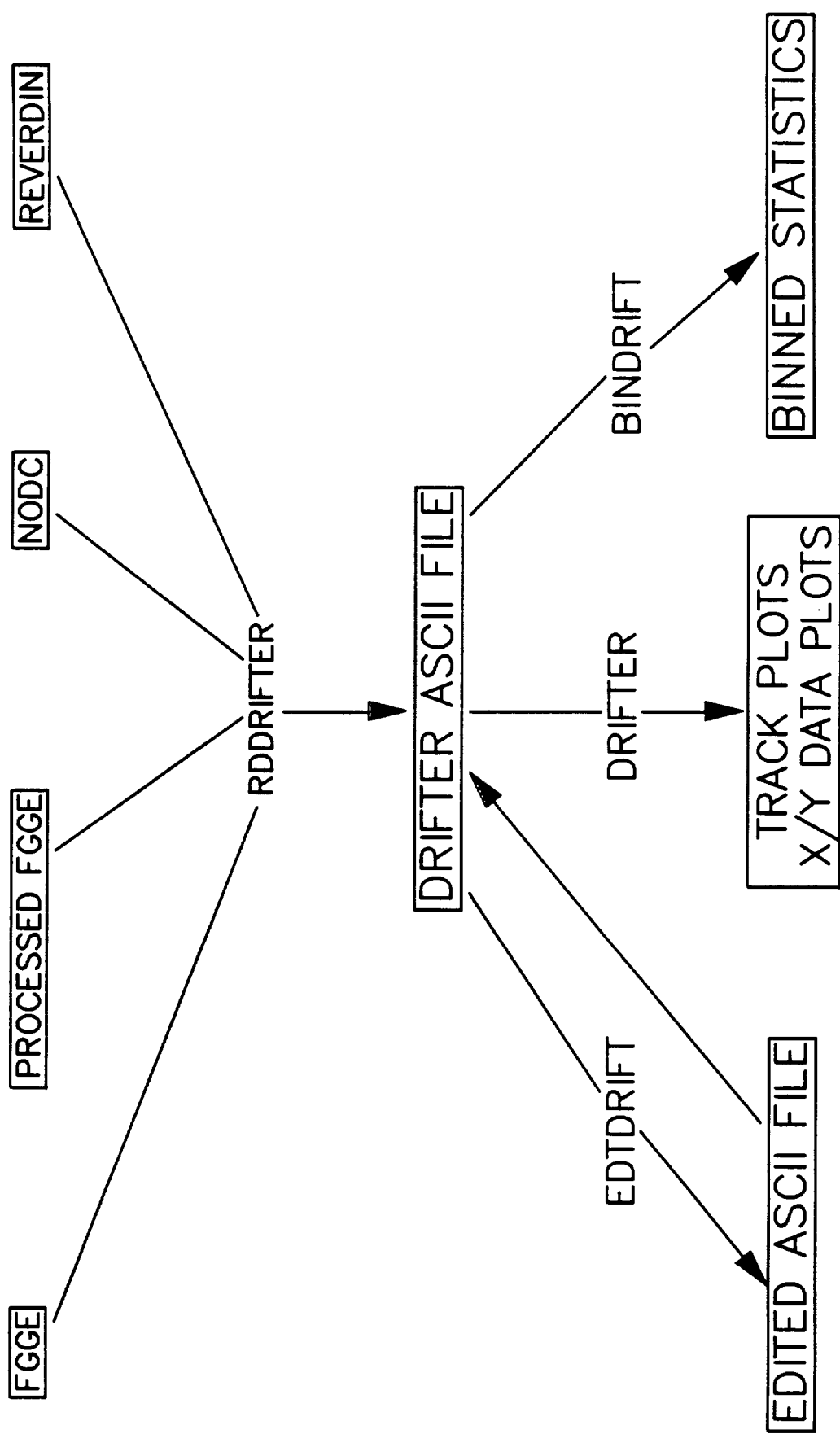
SEAPAK UNGRIDDED DATA PROCESSING

INSITU DATA



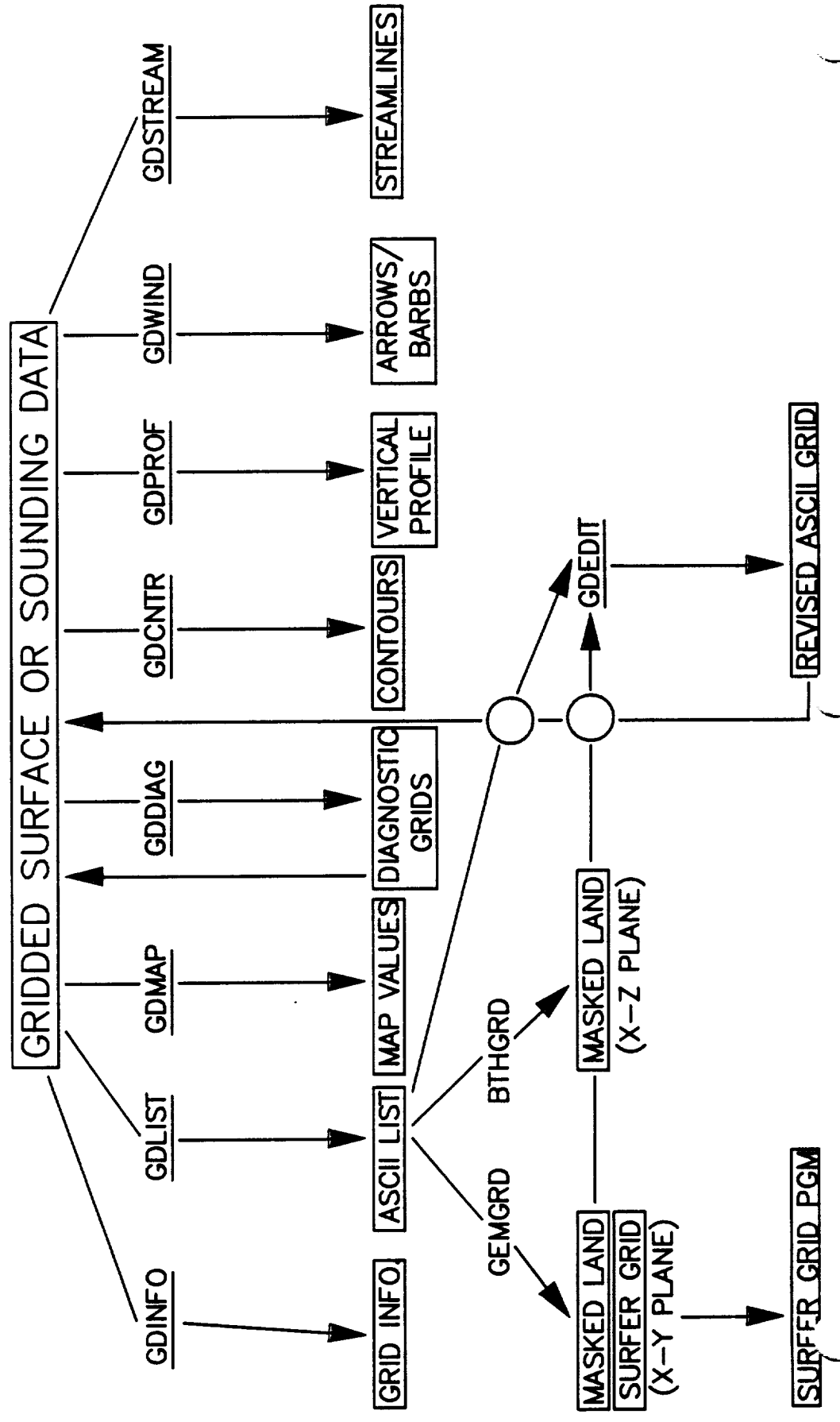
SEAPAK UNGRIDDED DATA PROCESSING

DRIFTER DATA



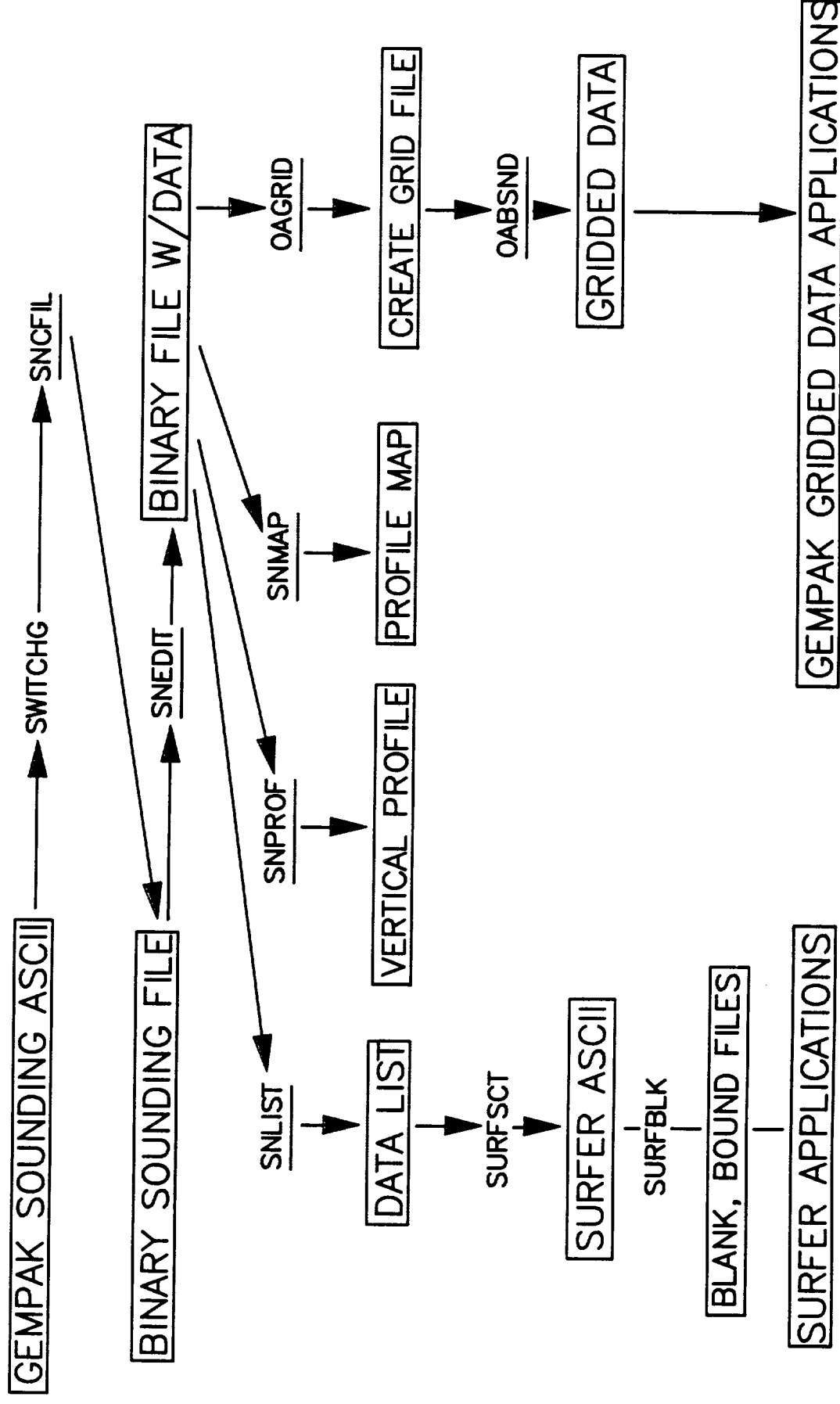
GEMPAK DATA PROCESSING USING SEAPAK INSITU DATA

GRIDDED DATA (GEMPAK PROGRAMS UNDERLINED)



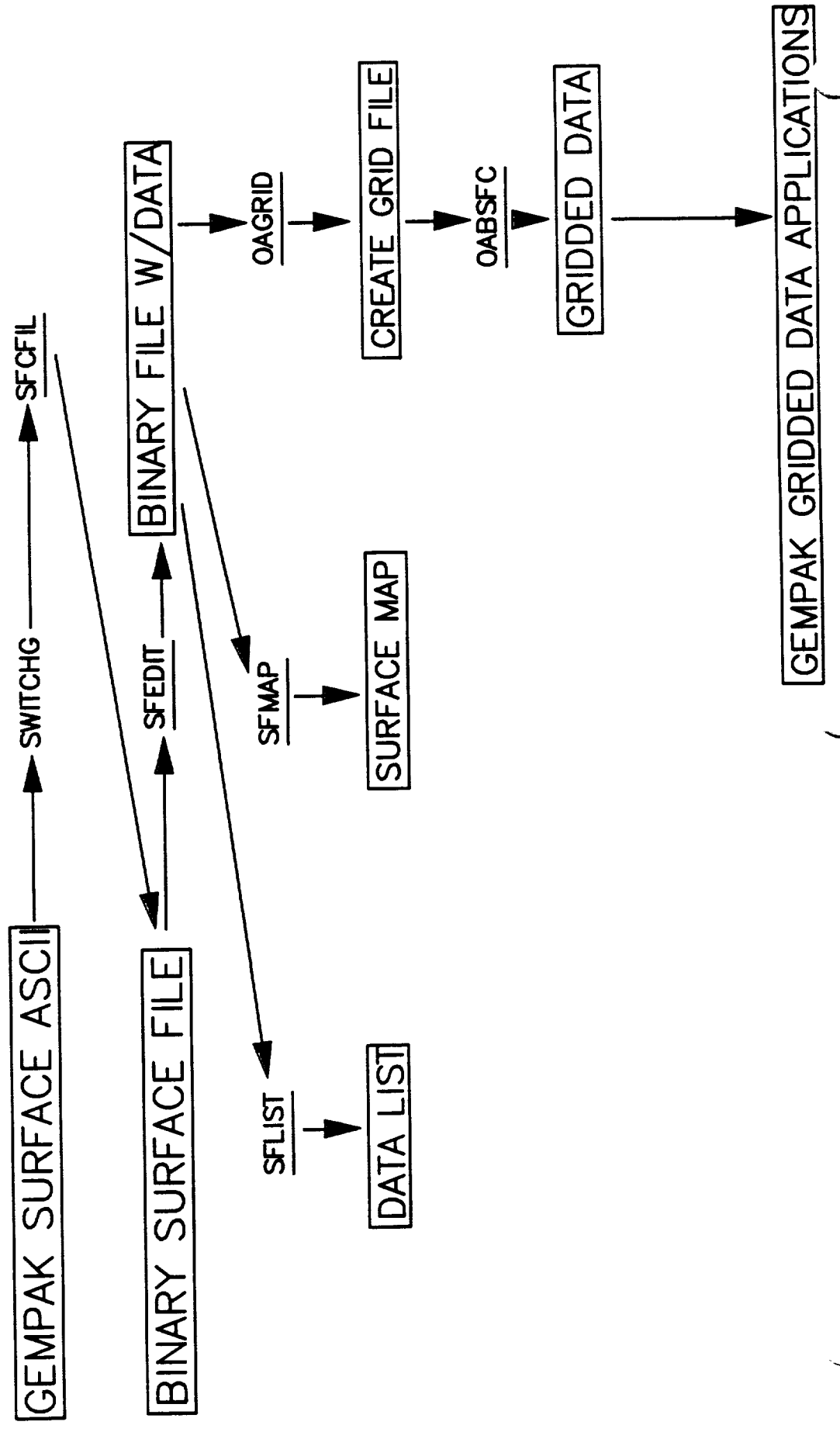
GEMPAK DATA PROCESSING USING SEAPAK INSITU DATA

SOUNDING DATA (GEMPAK PROGRAMS UNDERLINED)



GEMPAK DATA PROCESSING USING SEAPAK INSITU DATA

SURFACE DATA (GEMPAK PROGRAMS UNDERLINED)



SEAPAK ENVIRONMENTAL DATA MODULE

SUPPORTED CONVERSIONS

SEAPAK INPUT DATA TYPE

	SEAPAK						GEMPAK				SURFER/ GRAPHER	
	UNGRD ASCII	GRID ASCII	IMAGE FILE	TIME ASCII	STN PLOT	SFC ASCII	GRID ASCII	PROF ASCII	SCT ASCII	PROF ASCII		
XBT	*				*	*	*	*	*	*		
STN DATA	*				*	*	*	*	*	*		
CURRENT	*				*	*	*	*	*	*		
WATER TRANS	*				*	*	*	*	*	*		
CTD	*				*	*	*	*	*	*		
P GAUGE	*				*	*	*	*	*	*		
SO ATLAS	*	*	*	*	*	*	*	*	*	*		
SKIO	*				*	*	*	*	*	*		
FOCAL	*											
CLIMATE	*											
NANSEN CAST	*				*	*	*	*	*	*		
DRIFTER	*				*							
GFDL ASCII		*	*	*								
ZONE ASCII		*	*	*								
1-D CDF						*						
2-D, 3-D CDF		*	*	*			*					

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GLOSSARY AND ACRONYMS

GLOSSARY AND ACRONYMS

AOL	Airborne Oceanographic Lidar.
ASCII	American Standard Code for Information Interchange, a code for representing an alphanumeric and symbol character set in binary.
AVHRR	Advanced Very High Resolution Radiometer, used by SEAPAK to derive sea-surface temperatures. It is one of the sensors aboard the NOAA series of satellites. There are four channels for even numbered satellites such as NOAA-10 and five channels for odd numbered satellites such as NOAA-9. The radiance bands measured are 0.58-0.68, 0.725-1.1, 3.55-3.93, 10.5-11.5, and, for odd-numbered satellites, 11.5-12.5 um. (See GAC , HRPT , LAC , SST .)
Band	A wavelength range of spectrum within which a sensor makes measurements. (See AVHRR , CZCS , Channel .)
Bathy-thermograph	Instrument to measure water temperature as a function of depth. (See XBT .)
Bit Plane	Refers to one of independently usable graphics planes on an image system. Eight such planes are available for the IIS Model 75 in its graphics channels. Also called graphics plane .
Block	A quantity of storage or data in bytes. Equals 512 bytes unless otherwise specified.
Blotch	A colored-in area on a graphics plane which normally corresponds to a region of interest for associated image(s). A blotch enables the system to differentiate between the areas inside and outside this region when performing analyses on images. (See Region of Interest .)
CAC	Climate Analysis Center of NOAA, producers of monthly gridded sea surface temperature fields (means and anomalies) at 2 degree resolution. There are a blended product covering the entire world and an in situ product for the tropical and mid-latitude regions. These data sets can be plotted as contours or time series, made into images, or listed using SEAPAK environmental data programs.

Case 1 Water	Areas where phytoplankton and derivatives are the primary determinant of the water's optical characteristics. Such areas are normally in the open ocean.
Case 2 Water	Areas where water sediments are the primary determinant of the water's optical characteristics. Such areas are normally coastal regions.
CDF	Common Data Format of the NSSDC based at NASA/GSFC. This is a generic format used for storing gridded environmental and satellite data within the NCDS. Metadata, or information describing the data, can be stored in the CDF. Up to 10 dimensions, each of unlimited size, and up to 99 variables, will fit into a single CDF. CDFs are used as input to various SEAPAK environmental data programs that process meteorological and oceanographic gridded data.
CD-ROM	Compact disk, read-only medium. A number of archived SEAPAK datasets were ingested from CD-ROM.
Channel	1. Spectral band at which measurements are made by a radiometer. The CZCS has six such channels; the AVHRR, four or five. (See Band .) 2. Random access memory area in an image display system used to store digitized images. The IIS Model 75 can have up to 16 memory channels.
Channel Pair	On the IIS Model 75, two memory channels occupying the same board and which may be used to store 1024x512 pixel image. Independent scroll and zoom functions may be used to display any 512x512 area of such an image.
COADS	Comprehensive Ocean-Atmosphere Data Set, a combination of many different data types to form global climatologies included in the SEAPAK archive.
Counts	Refers to the digitized value of the radiance measured by a radiometer for an individual point (pixel). Usually applies to data prior to various corrections which convert them to physical units. CZCS uses 8 bits per pixel so count values range from 0 to 255. Count values are used to generate level-1 images.
CRT	CZCS calibrated radiance (level-1) tape.
CRCST	CZCS level-2 tape.

2 GLOSSARY AND ACRONYMS

C/STD	Conductivity/salinity/temperature measurements versus depth.
CZCS	Coastal Zone Color Scanner, a scanning radiometer aboard the Nimbus-7 satellite with channels at 0.433-0.453, 0.510-0.530, 0.540-0.560, 0.660-0.680, 0.700-0.800, and 10.5-12.5 um, and a resolution at nadir of 825 m. It was functional from November 1978 to June 1986.
DCL	Digital Command Language, the VAX/VMS command language.
DEC	Digital Equipment Corporation, makers of the VAX computers for which SEAPAK was developed.
Diagnostic	A scientific quantity derived from raw data observations. For instance, Ekman upwelling can be derived from raw FGGE zonal and meridional gridded wind components by SEAPAK's environmental module.
Display Coordinates	Refers to the vertical and horizontal coordinates of a picture element on an image display. Also called TV coordinates .
Dropping an Image	Refers to the loading of a digital image contained in a disk file into a memory channel of the IIS Model 75.
DSP	An image analysis system developed for CZCS and AVHRR data at the University of Miami.
ECMWF	European Centre for Medium Range Weather Forecasting, located in England; a major producer of global modelled datasets, including the winds which are part of SEAPAK's archive.
FGGE	The First GARP (Global Atmospheric Research Program) Global Experiment. This was a cooperative effort to study the world's atmosphere and oceans, involving more than 100 nations. Between December 1978 and November 1979, data from a variety of surface, upper air, and satellite sources were collected and assimilated into global grids. SEAPAK environmental data programs can plot or list both raw and derived (scalar or vector) FGGE quantities.
FNOC	Fleet Numerical Oceanography Center, provider of gridded wind data used by SEAPAK's environmental module.

FOCAL	Programme Francais Océan et Climat dans l'Atlantique Equatorial.
Full-Scan Image	A CZCS image whose width is 1,968 pixels--a full scan line. The number of lines may vary. The image is a full-resolution image produced by the program TP2DSK. The program WINDOW may be used to display such images and to create regular, 512x512 SEAPAK image files. Also referred to as full-width or full-size images.
GAC	Global Area Coverage, the lower resolution coverage provided by the AVHRR data. The resolution is approximately 4 km.
GALE	Genesis of Atlantic Lows Experiment which resulted in a collection of meteorological and oceanographic data designed to study coastal storm development. GALE was conducted from January to March, 1986, and its surface marine and SST oservations are part of the SEAPAK archive.
GEMPAK	General Meteorological Package, developed by the Severe Storms Branch, Laboratory for Atmospheres, NASA/GSFC. This is a large software package for analyzing and displaying various types of meteorological data, including: surface data, upper air sounding data, and gridded data. GEMPAK can also create gridded data from random observations by using objective analysis techniques. GEMPAK's programs may be accessed directly from SEAPAK's root menu. Also, SEAPAK's environmental module uses GEMPAK's subroutine library to perform gridded diagnostic computations.
GEMPLT	The plotting portion of GEMPAK. This software allows display of maps, text, grids, X/Y plots, contour lines, and wind barbs, arrows or streamlines. Full flexibility is given over the colors, lines, and markers used. Various map projections and output terminal/hard copy devices are supported. SEAPAK's environmental module uses GEMPLT to plot ancillary data.
GFDL	Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey.
Graphics Plane	One of the eight bit planes in the graphics memory. (See Bit Plane.)

Gray Level	Digitized value used to represent a pixel quantity. When displayed on an image system, such a value is assigned a gray shade or level. Normally, 8 bits per pixel are used for this digitization so that gray levels range from 0 (black) to 255 (white). The quantity represented may be count, level-1, level-2, or level-3 data.
GSFC	NASA's Goddard Space Flight Center in Greenbelt, Maryland.
HP	Hewlett Packard Corporation, manufacturer of the model 7550 pen plotter accessed by SEAPAK.
HRPT	High Resolution Picture Transmission, direct readout AVHRR data. (See LAC.)
IIS	International Imaging Systems, the company which produces the Model 75 imaging system used by SEAPAK.
Image Data File	A real-number, binary file generated by SEAPAK programs such as ADDF and DERIV which can be converted into an image file using STATDIS.
Image File	A 512x512-byte, flat file containing gray level values for an image which can be displayed on the IIS Model 75. Each byte represents one image pixel. Additional 512-byte records containing the header information may precede the image data. SEAPAK images typically contain one such header record.
Ingest	Data ingest or ingestion refers to the transfer of data from one medium (e.g., tape) to a more convenient medium (e.g., magnetic disk). It may be accompanied by reformatting or other, more involved processing.
Indexed File	A VAX/VMS file that is conceptually similar to a database. The file contains "key fields" used for data extraction. Randomly spaced data used within SEAPAK's environmental module are stored in this form.
I/O	Input/output.
LAC	Local Area Coverage, the higher resolution coverage provided by the AVHRR. The resolution is approximately 1 km.

Lag	A space or time interval separating points in correlation and spectral analyses.
Land Mask	A graphics depicting the location of land. Often used as an overlay to satellite imagery. May be used as a blotch to exclude processing of land or water areas in an image.
LAS	Land Analysis System, a software package developed by NASA/GSFC for the analysis of Landsat satellite images and which may be accessed directly from SEAPAK's root menu.
LAVC	Local Area VAX Cluster, a DEC product installed at the Laboratory for Hydrospheric Processes, GSFC, to network the VAX and MicroVAX computers on which SEAPAK has been implemented.
Level 1	Refers to a satellite image whose data have been corrected for sensor calibration. For CZCS, these data represent observed radiance values derived from the 8-bit count transmitted by the satellite.
Level 2	Refers to a satellite image whose data represents a geophysical parameter derived from level-1 images. To derive level-2 CZCS images, level-1 images from various bands of the same scene are used. Level-2 images include images such as those of water radiances, pigment concentrations, aerosol radiances, and diffuse attenuation for the CZCS or SST images for the AVHRR.
Level 3	Refers to a satellite image that has been mapped to a non-satellite perspective projection. Such mapping is normally (but not necessarily) performed on level-2 images. Normally for SEAPAK, level-3 (mapped) images are only those output by the projection program MAPIMG. (See Remap.)
Line	Refers to the vertical location or coordinate of a picture element when used in conjunction with "pixel." (See Display Coordinates.)
LUT	Look-up table. In SEAPAK, LUT refers to a look-up table used to define the pseudocoloring scheme of an image on the IIS Model 75.
M75	The IIS Model 75 image analysis and display system used by SEAPAK.

MCSST	Multi-channel sea surface temperatures. A gridded product produced as monthly means by NOAA and derived from AVHRR radiance data.
NASA	National Aeronautics and Space Administration.
NCDS	NASA Climate Data System, a software system for locating, accessing, manipulating, and displaying data from NASA research and development data sets and several correlative data sets.
NET	Nimbus Experiment Team. Each instrument on Nimbus-7 had a team of investigators who were selected through a NASA Announcement of Opportunity. This group was responsible for overseeing the development of the sensor and the algorithms for the geophysical products.
NMC	National Meteorological Center, provider of gridded wind data used in SEAPAK's environmental module.
NOAA	National Oceanic and Atmospheric Administration, Dept. of Commerce.
NOARL	Naval Oceanographic and Atmospheric Research Laboratory; formerly NORDA.
NODC	National Ocean Data Center, producer of many of the hydrographic datasets used by SEAPAK's environmental module.
NODS	NASA Ocean Data System, located at the NASA Jet Propulsion Laboratory, Pasadena, California.
NORDA	Naval Oceanographic Research and Development Activity; now NOARL.
NSSDC	National Space Science Data Center at NASA/GSFC. Maintains a large archive of space science and related datasets, including CZCS imagery, and develops software for listing and displaying these data.
OCF	The Oceans Computing (Computer) Facility at the GSFC Laboratory for Hydrospheric Processes.
OFM	Output Function Memory, a hardware component of the IIS Model 75.

Pixel	<p>1. The smallest element of a digital image for which a value is assigned. This may refer to the individual points at which a radiometer takes measurements or the picture elements of an image display. (See Sample.)</p> <p>2. Refers to the horizontal location or coordinate of a picture element when used in conjunction with "line." (See Display Coordinates.)</p>
Proc	Refers to a TAE process or procedure. SEAPAK programs are invoked via procs from SEAPAK's TAE interface. The distinction is often lost and "programs" and "procs" may be used interchangeably for SEAPAK.
Refresh Memory	Internal storage buffer memory residing in a display system and used for graphics or image displays. The data of the image or graphics are stored in the buffer memory and the display is refreshed from this buffer.
Region of Interest (ROI)	A portion of an image, corresponding to one or more blotch areas, to be processed by a program. Certain SEAPAK programs allow either the blotch (inside) or non-blotch (outside) areas to be specified as the ROI. (See Blotch .)
Registration	Refers to the process of manipulating an image so that its earth-surface points may be superimposed on those of another image or graphics display.
Remap	To project an image using the SEAPAK program MAPIMG to a standard map projection. (See Level 3 .)
RSMAS	Rosensteil School of Marine and Atmospheric Science of the University of Miami.
Sample	Usually refers to a data point along a scan line but also used interchangeably with pixel .
Scan Line	A line of measurements (samples) taken during one rotation of a satellite sensor across its flight path.
SEQUAL	Seasonal Response of the Equatorial Atlantic.
SkIO	Skidaway Institute of Oceanography, Georgia.
SST	Sea surface temperature, a level-2 product such as derived from AVHRR data by the SEAPAK program AV2IMG.

TAE	Transportable Applications Executive (or Environment), a powerful, standard user interface and applications executive developed at NASA/GSFC and used by SEAPAK.
TCL	TAE Command Language.
TOGA	Tropical Ocean-Global Atmosphere Experiment.
TOMS	The Total Ozone Mapping Spectrometer aboard the Nimbus-7 satellite. Uses backscattered ultraviolet to make total ozone measurements at a resolution of 50 to 150 km. Its data are used by SEAPAK programs to derive CZCS pigment concentrations.
TOVS	TIROS Operational Vertical Sounder, one of the sensors aboard the NOAA series of satellites; provides temperature and moisture data from the Earth's surface up through the stratosphere.
TV Coordinates	Same as display coordinates.
USGS	U.S. Geological Survey, an agency of the U.S. Dept. of the Interior.
VAX/VMS	An operating system used by DEC's VAX computers and required by SEAPAK.
WHOI	Woods Hole Oceanographic Institute, Woods Hole, Massachusetts.
WORM	"Write once, read many" optical disk used to store SEAPAK environmental datasets.
XBT	Expendable bathythermograph.

APPENDICES

- A. SEAPAK CDF Archive**
- B. SEAPAK Indexed Data Archive**
- C. SEAPAK Menu Tree**
- D. Summary List of Programs**

APPENDIX - SEAPAK CDF ARCHIVE

This is a listing of all NASA Common Data Format (CDF) files in the SEAPAK ancillary data archive. The set of VAX/VMS logical names pointing to the locations of these files is provided, followed by the names of the CDFs and a brief description of their contents.

<u>Logical Name</u>	<u>Data Type</u>
CAC	CAC SST
COADS	Comprehensive Ocean-Atmosphere Dataset
FLUX	COADS Max Planck Institute fluxes
FNOC	Fleet Numerical Oceanography Center winds
HYD	Hydrographic data
MCSST	NOAA MCSST
MET	1986 GALE surface data
MIX	NODC mixed layer/thermocline data
NMC	National Meteorological Center winds
OCOADS	Optical platter COADS datasets
ONODC	Optical platter NODC and misc. datasets
OWINDS	Optical platter wind datasets
OWINDS2	Second optical platter of wind dataset
SF	SEQUAL/FOCAL tropical datasets
TOGA	Optical platter TOGA dataset
TOMS	Nimbus-7 TOMS ozone datasets

The CDF file names contained in each directory represented by the logical names are listed below.

Logical Name: CAC

<u>CDF Name</u>	<u>Description</u>
CAC_SST_BLENDED	1982-91 means,anoms
CAC_SST_INSITU	1970-84 means,anoms
CAC_SST_BLENDED_MASK	1982-89 means,anoms (with landmask)
CAC_SST_INSITU_NEW	1970-81 means,anoms (re-analyzed)
SST_LANDMASK	high res. landmask to accompany SST

Logical Name: COADS

<u>CDF Name</u>	<u>Description</u>
COADS-ICE_SST_CLIMATOLOGY	1950-79 means,anoms

Logical Name: FLUX

<u>CDF Name</u>	<u>Description</u>
MPI_FLUX	Max Planck fluxes
HSIUNG_HEATFLUX	Heatflux means by month of the year

Logical Name: FNOC

<u>CDF Name</u>	<u>Description</u>
0179_0679_FNOC_UV	1st half 1979 winds

Logical Name: HYD

<u>CDF Name</u>	<u>Description</u>
UNESCO_RIVER_DISCHARGE_MONTHLY	369 river stations, 1807-1972
UNESCO_RIVER_DISCHARGE_ANNUAL	369 river stations, 1807-1972

Logical Name: MCSST

<u>CDF Name</u>	<u>Description</u>
MCSST	1979-86 AVHRR means, anoms

Logical Name: MET

<u>CDF Name</u>	<u>Description</u>
GALE_NCSU-SFCMARINE	100,000+ surface marine obs. from GALE (1986)

Logical Name: MIX

<u>CDF Name</u>	<u>Description</u>
NODCMX	1979-86 mixed layer, thermocline
LEVITUS_DPTH_MIX	Mixed layer depth climatology
FNOC_NH125_DPTH_MIX	125x125 mixed layer depths - north hem.
FNOC_NH63_DPTH_MIX	63x63 mixed layer depths - north hem.
FNOC_SH63_DPTH_MIX	63x63 mixed layer depths - south hem.

Logical Name: NMC

<u>CDF Name</u>	<u>Description</u>
7607-7612_NMCUVGLOB	2nd half 1976 u/v winds

Logical Name: OCOADS0/1 (COADS WORM platter, side B on DIATOM::LDB0/1)

<u>CDF Name</u>	<u>Description</u>
4601-4912_COADS_MSTG_GROUP3	COADS 1940's
5001-5912_COADS_MSTG_GROUP3	COADS 1950's
6001-6912_COADS_MSTG_GROUP3	COADS 1960's
7001-7912_COADS_MSTG_GROUP3	COADS 1970's
4601-4912_COADS_MSTG_GROUP4	COADS 1940's
5001-5912_COADS_MSTG_GROUP4	COADS 1950's
6001-6912_COADS_MSTG_GROUP4	COADS 1960's
7001-7912_COADS_MSTG_GROUP4	COADS 1970's
4601-4912_COADS_MSTG_GROUP5	COADS 1940's
5001-5912_COADS_MSTG_GROUP5	COADS 1950's
6001-6912_COADS_MSTG_GROUP5	COADS 1960's
7001-7912_COADS_MSTG_GROUP5	COADS 1970's
4601-4912_COADS_MSTG_GROUP6	COADS 1940's
5001-5912_COADS_MSTG_GROUP6	COADS 1950's
6001-6912_COADS_MSTG_GROUP6	COADS 1960's
7001-7912_COADS_MSTG_GROUP6	COADS 1970's
4601-4912_COADS_MSTG_GROUP7	COADS 1940's
5001-5912_COADS_MSTG_GROUP7	COADS 1950's
6001-6912_COADS_MSTG_GROUP7	COADS 1960's
7001-7912_COADS_MSTG_GROUP7	COADS 1970's
MPI_FLUX	Max Planck fluxes
COADS-ICE_SST_CLIMATOLOGY	1950-79 means, anoms

Logical Name: ONODC0/1 (COADS WORM platter, side A on
DIATOM::LDB0/1)

<u>CDF Name</u>	<u>Description</u>
LEVITUS_DPTH_MIX	Mixed layer depth climatology
LEVITUS_OCEANTMP	19-level ocean temp. climatology
NODCMX	1979-86 mixed layer, thermocline
LEVITUS_STATISTICS	30-level seasonal ocean parms
LEVITUS_SEASONAL	24-level seasonal analyses
SOAGPDS	Southern Ocean Atlas (gridded)
LEVITUS_ANNUAL_2D	33-level annual ocean parms
LEVITUS_ANNUAL_3D	33-level annual ocean parms
TOPOGRAPHY	NORDA bathymetry
SEQ_FOC_METEO	FOCAL '64-'84 monthly SST, stress
SEQ_FOC_STRESS	SEQUAL '82-'85 daily stress
WHOIDRIFT	WHOI (Richardson) shipdrift
UNESCO_RIVER_DISCHARGE_	369 river stations, 1807-1972
MONTHLY	
UNESCO_RIVER_DISCHARGE_	369 river stations, 1807-1972
ANNUAL	
SST	GALE AVHRR-derived SST
NODC_SALINITY_STATS	72-level Pacific statistics
NODC_TEMPERATURE_STATS	72-level Pacific statistics
GALE_NCSU-SFCMARINE	100,000+ surface marine obs. from GALE (1986)
HSIUNG_HEATFLUX	Heatflux means by month of year
ISCCP_83-85	TOVS cloud amount, 1983-1985
ISCCP_86-88	TOVS cloud amount, 1986-1988
FNOC_NH125_DPTH_MIX	125x125 mixd layer depths - north hem.
FNOC_NH63_DPTH_MIX	63x63 mix layer depths - north hem.
FNOC_SH63_DPTH_MIX	63x63 mixed layer depths - south hem.
FNOC_NH_DPTH_MIX	Mixed layer depths - north hem.
FNOC_SH_DPTH_MIX	Mixed layer depths - south hem.
COADS-ICE_SST_CLIMATOLOGY	1950-79 mean, anomaly
CAC_SST_INSITU_NEW	1970-81 means, anoms (re-analyzed)
CAC_SST_LANDMASK	high res. landmask for SST
NMC_DAILY_SFC	1973-85 daily sea-level pressure
NMC_MONTHLY_GRID	1973-84 monthly data
TRENBERTH_MON_CLIM	Wind stress by month of year
TRENB-WIND_STRESS	1980-86 stress
FSU_NDN	1977-88 Indian Ocean pseudo-stress
FSU_PACWIN	1961-88 Pacific pseudo-stress
SMMR_SEA_ICE_MONTHLY	1978-87 ice concentration, Antarctic 293x293 grid
TOGA1-SEAHGT_DAILY	TOGA sea height, 1957-89 (tropics)
TOGA1-SEAHGT_HOURLY	TOGA sea height, 1973-89 (tropics)
TOGA1-SEAHGT_MONTHLY	TOGA sea height, 1957-89 (tropics)
CAC_SST_BLENDED	1982-91 means, anoms
TOGA-ECMWF_SA-89A	144x73 12 hour surface data
TOGA-ECMWF_UA-89A	144x73 1000 mb 12 hour data

Logical Name: OWINDS0/1 (WINDS WORM platter, side B on
DIATOM::LDB0/1)

<u>CDF Name</u>	<u>Description</u>
0179_0679_FNOC_UV	1st half 1979 winds
0779_1279_FNOC_UV	2nd half 1979 winds
0180_0680_FNOC_UV	1st half 1980 winds
0780_1280_FNOC_UV	2nd half 1980 winds
0181_0681_FNOC_UV	1st half 1981 winds
0781_1281_FNOC_UV	2nd half 1981 winds
0182_0682_FNOC_UV	1st half 1982 winds
0782_1282_FNOC_UV	2nd half 1982 winds
0183_0683_FNOC_UV	1st half 1983 winds
0783_1283_FNOC_UV	2nd half 1983 winds
0184_0684_FNOC_UV	1st half 1984 winds
0784_1284_FNOC_UV	2nd half 1984 winds
0185_0685_FNOC_UV	1st half 1985 winds
0785_1285_FNOC_UV	2nd half 1985 winds
0186_0686_FNOC_UV	1st half 1986 winds
0786_1286_FNOC_UV	2nd half 1986 winds
0187_0687_FNOC_UV	1st half 1987 winds
7607-7612_NMCUVGLOB	1976 u/v winds
7701-7712_NMCUVGLOB	1977 u/v winds
7801-7812_NMCUVGLOB	1978 u/v winds
7901-7912_NMCUVGLOB	1979 u/v winds
8001-8012_NMCUVGLOB	1980 u/v winds
8101-8112_NMCUVGLOB	1981 u/v winds
8201-8212_NMCUVGLOB	1982 u/v winds
8301-8312_NMCUVGLOB	1983 u/v winds
8401-8412_NMCUVGLOB	1984 u/v winds
8501-8512_NMCUVGLOB	1985 u/v winds
8601-8612_NMCUVGLOB	1986 u/v winds
FGGE_DEC78	FGGE3B, 12/78 winds,height
FGGE_JAN79	FGGE3B, 1/79 winds,height
FGGE_FEB79	FGGE3B, 2/79 winds,height
FGGE_MAR79	FGGE3B, 3/79 winds,height
FGGE_APR79	FGGE3B, 4/79 winds,height
FGGE_MAY79	FGGE3B, 5/79 winds,height
FGGE_JUN79	FGGE3B, 6/79 winds,height
FGGE_JUL79	FGGE3B, 7/79 winds,height
FGGE_AUG79	FGGE3B, 8/79 winds,height
FGGE_SEP79	FGGE3B, 9/79 winds,height
FGGE_OCT79	FGGE3B, 10/79 winds,height
FGGE_NOV79	FGGE3B, 11/79 winds,height
HELLERMAN_WIND_STRESS	u,v stress climatology

Logical Name: OWINDS20/1 (WINDS WORM platter, side A on
DIATOM::LDB0/1)

<u>CDF Name</u>	<u>Description</u>
ECMWF_UV_1980	ECMWF 1980 winds
ECMWF_UV_1981	ECMWF 1981 winds
ECMWF_UV_1982	ECMWF 1982 winds
ECMWF_UV_1983	ECMWF 1983 winds
ECMWF_UV_1984	ECMWF 1984 winds
ECMWF_UV_1985	ECMWF 1985 winds
ECMWF_UV_1986	ECMWF 1986 winds
ECMWF_UV_1987	ECMWF 1987 winds
ECMWF_WIND_MEAN	1980-1987 monthly means
0178_0678_FNOC_UV	1st half 1978 winds
0778_1278_FNOC_UV	2nd half 1978 winds
0787_1287_FNOC_UV	2nd half 1987 winds
0188_0688_FNOC_UV	1st half 1988 winds
0788_1288_FNOC_UV	2nd half 1988 winds
0189_0689_FNOC_UV	1st half 1989 winds
0789_1289_FNOC_UV	2nd half 1989 winds
FNOC_UV_9001-9006	1st half 1990 winds
FNOC_UV_9007-9012	2nd half 1990 winds

Logical Name: SF

<u>CDF Name</u>	<u>Description</u>
SEQ_FOC_METEO	FOCAL '64-'84 monthly SST, stress
SEQ_FOC_STRESS	SEQUAL '82-'85 daily stress

Logical Name: OTOGA0/1 (TOGA WORM platter, side B on
DIATOM::LDB0/1)

<u>CDF Name</u>	<u>Description</u>
TOGA-ECMWF_SA-85A	Jan.-Jun. 1985 surface
TOGA-ECMWF_SA-85A	Jul.-Dec. 1985 surface
TOGA-ECMWF_SA-86A	Jan.-Jun. 1986 surface
TOGA-ECMWF_SA-86B	Jul.-Dec. 1986 surface
TOGA-ECMWF_SA-87A	Jan.-Jun. 1987 surface
TOGA-ECMWF_SA-87B	Jul.-Dec. 1987 surface
TOGA-ECMWF_SA-88A	Jan.-Jun. 1988 surface
TOGA-ECMWF_SA-88B	Jul.-Dec. 1988 surface
TOGA-ECMWF_SA-89A	Jan.-Jun. 1989 surface
TOGA-ECMWF_SA-89B	Jul.-Dec. 1989 surface
TOGA-ECMWF_UA-85A	Jan.-Jun. 1985 upper air
TOGA-ECMWF_UA-85B	Jul.-Dec. 1985 upper air
TOGA-ECMWF_UA-86A	Jan.-Jun. 1986 upper air
TOGA-ECMWF_UA-86B	Jul.-Dec. 1986 upper air
TOGA-ECMWF_UA-87A	Jan.-Jun. 1987 upper air
TOGA-ECMWF_UA-87B	Jul.-Dec. 1987 upper air
TOGA-ECMWF_UA-88A	Jan.-Jun. 1988 upper air
TOGA-ECMWF_UA-88B	Jul.-Dec. 1988 upper air
TOGA-ECMWF_UA-89A	Jan.-Jun. 1989 upper air
TOGA-ECMWF_UA-89B	Jul.-Dec. 1989 upper air
TOGA-TAO_OCEANTMP	Water temperature, depth
TOGA-TAO_SURFACE	Atmospheric temp., u and v winds
COADS_MSTG2_GROUP3_8001-8912	COADS 1980's group 3
COADS_MSTG2_GROUP4_8001-8912	COADS 1980's group 4
COADS_MSTG2_GROUP5_8001-8912	COADS 1980's group 5
COADS_MSTG2_GROUP6_8001-8912	COADS 1980's group 6
COADS_MSTG2_GROUP7_8001-8912	COADS 1980's group 7
ISCCP-REGRID_83-85	TOVS cloud amount, 1983-1985 (ordered by time)
ISCCP-REGRID_86-88	TOVS cloud amount, 1986-1988 (ordered by time)

Logical Name: TOMS

<u>CDF Name</u>	<u>Description</u>
TOMS_1978	1978 daily Nimbus-7 TOMS ozone
TOMS_1979	1979 daily Nimbus-7 TOMS ozone
TOMS_1980	1980 daily Nimbus-7 TOMS ozone
TOMS_1981	1981 daily Nimbus-7 TOMS ozone
TOMS_1982	1982 daily Nimbus-7 TOMS ozone
TOMS_1983	1983 daily Nimbus-7 TOMS ozone
TOMS_1984	1984 daily Nimbus-7 TOMS ozone
TOMS_1985	1985 daily Nimbus-7 TOMS ozone
TOMS_1986	1986 daily Nimbus-7 TOMS ozone

APPENDIX - SEAPAK INDEXED DATA ARCHIVE

Nongridded, or random, in situ hydrographic data to be used by SEAPAK are stored in VAX/VMS indexed files. These files allow for the establishment of key fields, typically latitude, longitude, date and time, providing an easy and quick way to query the data. In SEAPAK, separate indexed files have been created for logical groupings of random data--e.g. all of the XBTs from the SEQUAL/FOCAL experiment.

SEAPAK's indexed file archive includes data of many types and from a number of sources and field experiments. A summary of the contents of each dataset may be found in the file CDF\$LIST:ENVDATA.LIST. Also, the SEAPAK proc ENVQRY may be used to determine which datasets contain specific parameters the user may be interested in. All datasets have been archived on 8mm tape. However, certain datasets are small enough to reside on magnetic disk. For these smaller datasets, the following list presents the logical names that indicate their disk locations on the OCF VAX cluster. Datasets located only on 8mm tape must be restored to magnetic disk before querying.

<u>Logical Name</u>	<u>Data Type or Source</u>
CUR	Current meter
CLM	Climate
FOCAL\$DIR	FOCAL
HYD	Hydrographic
NODC\$DIR	NODC Southern Ocean
SF	SEQUAL/FOCAL
WTP	Water transparency
XBT	XBT

A suite of programs have been created to handle the query and extraction of data from the indexed files. Each program handles one or more major data types and some of the programs have batch as well as interactive execution. The output of each query program may include a listing of the stations/sites at which the data were collected as well as a separate listing of the actual data. The station listing can be used by the SEAPAK proc PLOTLOC to plot the locations over a SEAPAK image. The data listing can often be used directly in another SEAPAK application (such as MEANPROF or DENSPROF) or converted to a form compatible with other graphics/analysis packages. SEAPAK supports conversion of data to GEMPAK's surface and vertical profile format, as well as that of Golden Software Inc's Surfer 3-D display package. Since these packages provide extensive capabilities to display and plot the data in a convenient form, their functions have not been duplicated by SEAPAK.

The following list presents the filenames associated with each data type and source, the procs that may be used to query the data in those files, and the application procs that may be used in

conjunction with the output of the query procs. An asterisk in a filename is used as a wild card to represent the digit characters "1" and "2" in the names of each file pair comprising one indexed dataset.

Data Type: Station

Application Procs: PLOTLOC, ASC2GEM, MEANPROF, DENS PROF

Source: NODC

Query Procs: RDNODCSD_CD, RDNCSDBA_CD

Filenames: PAC_SD2*.DAT (8mm)

Query Procs: RDNODCSD, RDNCSDBA

Filenames: NOSX*.DAT (8mm), HYD:NC_FG_SD*.DAT,
HYD:NC_NAT_SD*.DAT

Source: SkIO

Query Procs: RDSKDWAY, RDSKDBA

Filenames: HYD:SKD_SA*.DAT

Source: French cruise

Query Proc: RDFRENSD

Filenames: HYD:FRENCH_TROP_SD*.DAT

Application Procs: PLOTLOC

Source: SkIO

Query Procs: RДФOCAL

Filenames: FOCAL\$DIR:FILE10IX.DATA

Data Type: Bathythermograph

Query Procs: RDXBT, RDXBTBA

Application Procs: PLOTLOC, ASC2GEM, MEANPROF, DENS PROF

Source: NODC

Filenames: PAC_XBT*.DAT (8mm), PAC_SBT*.DAT (8mm),
PAC_IBT*.DAT (8mm), NXXBT*.DAT (8mm),
XBT:FOC_SEQ_XBT*.DAT, XBT:NC_FG_XBT*.DAT

Source: Reverdin (FOCAL)

Filenames: REVDR_XBT*.DAT (8mm)

Data Type: C/STD

Application Procs: PLOTLOC, ASC2GEM, MEANPROF, DENS PROF

Source: NODC (SEQUAL/FOCAL)

Query Procs: RDSFCTD

Filenames: SF:SEQ_FOC_CTD*.DAT, SF:SEQ_FOC_VCTD*.DAT

Source: NODC

Query Procs: RDNODCSD_CD, RDNCSDBA_CD

Filenames: PAC_STD*.DAT (8mm)

Query Procs: RDNODCSD, RDNCSDBA

Filenames: HYD:NC_FG_CS*.DAT, HYD:NC_NAT_CS*.DAT

Data Type: Current meter

Source: NODC (SEQUAL/FOCAL)

Query Procs: RDNODCMD, RDNCMDBA

Application Procs: PLOTLOC

Filenames: SF:NC_SEQ_FOC_MD*.DAT, CUR:NC_SEQ_FOC_MD*.DAT

2 APPENDIX - SEAPAK INDEXED DATA ARCHIVE

Data Type: Nansen cast
Source: NODC (SEQUAL/FOCAL)
Query Procs: RDNODCSD, RDNCSDBA
Application Procs: PLOTLOC, ASC2GEM, MEANPROF, DENS PROF
Filenames: SF:SEQ_FOC_NANCAST*.DAT, HYD:SEQ_FOC_NANCAST*.DAT

Data Type: Water transparency
Source: NODC
Query Procs: RDNODCWT
Application Procs: PLOTLOC
Filenames: WTP:NC_WORLD*.DAT

Data Type: Climate
Source: NODC
Query Procs: RDNCCLM
Filenames: CLM:NC_MONTH*.DAT

Data Type: Drifter
Query Procs: RDDRIFTER
Application Procs: PLOTLOC, DRIFTER, EDTDRIFT, BINDRIFT
Source: NODC (SEQUAL/FOCAL)
Filenames: SF:NC_SEQ_FOC_DR*.DAT
Source: FGGE
Filenames: FGGE_DR*.DAT (8mm)
Source: Patterson (FSU) processed FGGE drifters
Filenames: FGGE_PATDR*.DAT (8mm)
Source: Reverdin (FOCAL)
Filenames: REV_DR*.DAT (8mm)

Data Type: Pressure gauge
Source: NODC (SEQUAL/FOCAL)
Query Procs: RDNODCPG
Application Procs: PLOTLOC
Filenames: SF:NC_SEQ_FOC_PG*.DAT

Data Type: Various from Southern Ocean Atlas
Source: NODC
Query Procs: RDSOADS
Application Procs: PLOTLOC, ASC2GEM, MEANPROF, DENS PROF
Filenames: NODC\$DIR:SOADS_IDX*.DAT

APPENDIX - SEAPAK MENU TREE

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SEAPAK . . . . . Main menu
-INGEST . . . . . CZCS, AVHRR ingest; AVHRR level 2
-CZCSL2 . . . . . CZCS level-2 processing
  -ATMOS . . . . . CZCS atmospheric correction
  -L2PROD . . . . . CZCS level-2 products
-GEOGRAPHIC . . . . . Projection/navigation
  -OVERLAY . . . . . Geographic overlays
-IMGFILE . . . . . Image manipulation
  -EXTRACT . . . . . Image data extraction
    -ASCII . . . . . ASCII image data output
  -ANALYSIS . . . . . Image data analysis
    -MATH . . . . . Mathematical analysis
    -STAT . . . . . Statistical analysis
  -HEADER . . . . . Image header manipulation
  -IMGUTIL . . . . . Image manipulation utilities
  -DSP . . . . . DSP image format routines
-DISPLAY . . . . . IIS Model 75 programs
  -INITIAL . . . . . M75 initialization routines
  -MEMORY . . . . . Memory channels manipulation
  -CURSOR . . . . . M75 cursor routines
  -GRAPHICS . . . . . M75 graphics programs
  -COLOR . . . . . M75 image color processing
    -LUT . . . . . Look-up table manipulation
  -MOSAIC . . . . . Mosaic programs
-GENUTIL . . . . . General utility programs
-ENVIRO . . . . . Environmental data processing
  -ENVIROIN . . . . . Environmental data ingest
    -INDEXIN . . . . . Ingest as indexed files
    -NODCIDX . . . . . NODC data ingest
    -CDFIN . . . . . Ingest as CDF files
  -ENVIROLIST . . . . . Environmental data extraction
    -NODCLIST . . . . . NODC data extraction
    -GEM4LIST . . . . . GEMPAK4-format data extraction
    -MISCLIST . . . . . Miscellaneous data extraction
  -ENVIROANAL . . . . . Environmental data analysis
    -GRIDANL . . . . . Gridded data analysis
    -UNGRIDANL . . . . . Ungridded data processing
    -UTILANL . . . . . Data analysis utilities
-DEMOS . . . . . On-line demonstration programs
  -PROGDEMO . . . . . Demos of SEAPAK programs
    -CZCSPROG . . . . . Demos of CZCS programs
    -ANCPROG . . . . . Environmental data demos
  -PRODDEMO . . . . . Demos of SEAPAK products

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APPENDIX - SUMMARY LIST OF PROGRAMS

SEAPAK

-INGEST

- TP2IMG - CZCS level-1 tape ingest
- DK2IMG - CZCS level-1 disk ingest
- TP2DSK - Full-scan, multi-scene, CZCS level-1 tape ingest
- WINDOW - Full-scan CZCS img display; regular img generatn
- AV2IMG - AVHRR level-1 tape ingest and level-2 processing
- TRAKIN - Aircraft/ship track line data ingest

-CZCSL2

- L2BOX - Localized level-2 analysis
- L2BOXD - Dual-algorithm, localized level-2 analysis
- FLAGLC - Land/cloud flag reprocessing
- LANCLD - Land/cloud flag reprocessing
- THRES - Land/cloud flag determination

-ATMOS

- CLRWAT - Angstrom exponent determination
- SCREEN - Valid clear-water pixel display
- ANGST - Angstrom exponent determination
- OZONE - TOMS ozone data/optical thickness listing

-L2PROD

- L2MULT - CZCS level-2 product generation
- L2SNGL - CZCS level-2 product generation
- L2GAC - CZCS level-2 GAC simulation
- L2DUAL - CZCS level-2 product generation
- EPSILON - Epsilon image generation
- RING - Mask-out sensor ringing

-GEOGRAPHIC

- REGIST - Image translation
- MAPIMG - Image map projection
- LATLON - Latitude/longitude determination
- GRIDPT - Latitude/longitude grid point overlay
- ASCCST - Coastline latitude/longitude listing

-OVERLAY

- GRID - Latitude/longitude grid overlay
- UNIGRID - Rectangular grid overlay
- COAST - Coastline/geographic features overlay
- BATHY - Bathymetry overlay
- CONTOUR - Image contouring
- REGION - Area-of-interest border overlay
- TRACK - Aircraft/ship track line data analysis

-IMGFILE

-EXTRACT

- READ - Data extraction for point or box area
- RLINE - Data extraction for line

- ASCII**
 - ASCOUT - ASCII output from rectangular subset of img
 - ASCIMG - ASCII output from rectangular subset of img
 - ASCBLO - ASCII output from region-of-interest
 - ASCCNV - File delimiter manipulation
- ANALYSIS**
 - MATH**
 - ADDF - Additn/subtractn/exponentiatn of img files
 - MEANF - Averaging of image files
 - LOGF - Logarithm of an image file
 - MULTF - Multiplicatn/division/exp. of two img files
 - DERIV - Derivatives of an image
 - STATDIS - Image generation from real-valued data file
 - IMGSUM - Image summation
 - IMGMULT - Image multiplication
 - DIFFI - Difference of two image files
 - ARRAY - Data array manipulation
 - STAT**
 - SCATT - Scattergram plot
 - CORCO - Correlation coefficient
 - XCORR - Cross autocorrelation vs. lags
 - HIST - Frequency distribution
 - VARIOG - Semivariance vs. lags
 - MV - Mean/variance image generation
 - EOF - Empirical orthogonal function analysis
 - EOFLOT - EOF image display and scaling
 - MEM - Maximum entropy method spectral analysis
 - TSERIES - Time series statistics plot
- HEADER**
 - DMPHDR - Display/print file header
 - MODHDR - Change header information
 - CONTROL - Control-point file definition
- IMGUTIL**
 - FILLA - Filtering and pixel replacement
 - FILLM - Interactive pixel replacement
 - FIXLIN - Image scan line replacement
 - IMATCH - Sets gray values using other img as criterion
 - RESCALE - Image rescaling
 - MERGE - Merge multiple images
- DSP**
 - L2CON - Pigment image transformations
 - ZONE - Meridional analysis of productivity
 - BZONE - Regional analysis of productivity
 - DSPIMG - Convert DSP image to SEAPAK image
 - PSTIMG - Create SEAPAK image from PST file
 - PSTMATCH - Extract correlative data from PST files
 - NODSST - Create SEAPAK image from NODS SST file

-DISPLAY

-INITIAL

- ALLOC - Allocate IIS Model 75 terminal
- INT - Initialize refresh memory
- GRPINTL - Initialize graphics channel
- CLR - Erase refresh memory
- DEALLOC - Deallocate IIS Model 75 terminal

-MEMORY

- IMAGE - Display image on IIS Model 75
- TODISK - Save displayed image on disk with header
- IMAGSAV - Save displayed image on disk without header
- SELECT - Select refresh memory to display
- LOO - Loop refresh memories
- IMGEDIT - Manipulation of displayed image
- ZOOM - Magnification of displayed image
- FEED - Copy displayed refresh memory to another
- FADE - Multi-band frame blending
- IISLST - List refresh memory contents
- GREYBAR - Display gray-level bar

-CURSOR

- CURON - Turn cursor on
- CUROFF - Turn cursor off
- CURREAD - Display cursor location
- MARK - Gray-level and cursor location
- CURBOX - Definition/operations for box cursor

-GRAPHICS

- BPINIT - Graphics plane initialization
- BPCOLOR - Graphics plane color assignment
- BPSAV - Save/restore graphics to/from disk file
- BPEDIT - General graphics plane editing
- DLINE - Draw line
- ANNOTATE - Annotation program
- BLOTCH - Define region-of-interest
- GRPOFF - Turn off graphics planes

-COLOR

-LUT

- LOADLUT - Load linear or inverted LUT
- LUTMAP - Graphical display of current LUT
- LUTMOD - LUT modification
- CURMOD - Cursor-driven LUT modification
- STRETCH - Linear contrast stretching
- PLI - Piecewise linear contrast stretching
- TABLOAD - Load LUT into refresh memory
- TABSAV - Save LUT as disk file
- PAINT - False color palette development
- PIXLINE - Cursor location and RGB values
- COLBAR - Color bar creation

-MOsaIC

- MOsaIC - Mosaic image creation
- RGBDIS - Display image mosaic
- DICOMED - Dicommed tape generation

-GENUTIL

- TAPUTL - VMS tape utility
- SPBATCH - SEAPAK batch job execution
- NEWS - Display program updates
- COMPRESS - File compression

-ENVIRO

-ENVIROIN

- RDFFGE - Read FGGE data from NCDS
- CACEXT - Read CAC SST data from NCDS
- NOAAEXT - Read MCSST data from NCDS
- CURMET - Read current meter data from RSMAS
- TPTODK - Read NODC ASCII data
- CNVGRD - Convert foreign grids to SEAPAK format

-INDEXIN

- IXSKDWAY - Index hydrographic data from SkIO
- IXFGGEDR - Index FGGE IIB drifter data
- IXPATDR - Index processed (Patterson) FGGE IIB drifters
- IXREVDR - Index FOCAL (Reverdin) drifters
- IXXBT - Index NODC or FOCAL XBT data
- IXFRENSD - Index tropical Atlantic French cruise data

-NODCIDX

- IXNODCSD - Index station/low-resolution CTD data
- IXNODCSD_CD - Index statn/low-res. CTD data from CD-ROM
- IXNODCMD - Index current meter data
- IXNODCDR - Index NODC drifter data
- IXNODCPG - Index NODC pressure gauge data
- IXSFCTD - Index SEQUAL CTD data
- IXSFNAN - Index SEQUAL/FOCAL Nansen cast data
- IXNODCWT - Index water transparency data
- IXNCCLM - Index temperature climatology
- IXSOADS - Index NODC Southern Ocean Atlas data

-CDFIN

- CDFNODCMX - Create CDF of mixed layer data
- SOAGPCDF - Create CDF of Southern Ocean Atlas grids
- CDFDRIFT - Create CDF from WHOI (Rich.) shipdrift data
- CDFSFMET - Create CDF from Servain's FOCAL dataset

-ENVIROLIST

- CDFLST - List contents of CDF
- CDF1D2GM - Convert 1-D CDF to GEMPAK surface file
- ASCENV - Extract ASCII data from CDF
- ASCRANGE - Find range of values in ASCII files
- ASCFUNC - Functions for environmental data ASCII files
- PLOTLOC - Plot station locations on image
- ENVQRY - Query env. data filenames based on parameter

- NODCLIST**
 - RDNODCSD - Read station data index file
 - RDNCSDBA - Read station data index file (batch)
 - RDNOCSDS_CD - Read statn data indxd file (CD-ROM format)
 - RDNCSDBA_CD - Read statn data indxd file (CD-ROM; batch)
 - RDNODCWT - Read water transparency data
 - RDNODCMD - Read current meter data
 - RDNCMDBA - Read current meter data (batch)
 - RDNODCDR - Read NODC drifter data
 - RDNODCPG - Read NODC pressure gauge data
 - RDNCCLM - Read temperature climatology data
 - RDSOADS - Read ungridded Southern Ocean Atlas data
- GEM4LIST**
 - ASC2GEM - Convert in situ ASCII data to GEMPAK4 ASCII
 - SURFSCT - Convert GEMPAK4 sounding ASCII to Surfer ASCII
 - BTHGRD - Mask bathymetry in GEMPAK4 in situ section ASCII
 - BLKGRD - Mask bathymetry in GEMPAK4 gridded ASCII
 - GEMGRD - Operations on GEMPAK4 ASCII grids
- MISCLIST**
 - RDSKDWAY - Read SkIO hydrographic station data
 - RDSKDBA - Read SkIO hydrographic station data (batch)
 - RDFOCAL - Read FOCAL mixed layer data
 - RDSFCTD - Read SEQUAL CTD/VCTD data
 - RDDRIFTER - Read NODC, FGGE, FOCAL drifter data
 - RDXBT - Read NODC or SEQUAL/FOCAL XBT data
 - RDXBTBA - Read NODC or SEQUAL/FOCAL XBT data (batch)
 - SURFBLK - Create blanking/boundary files for Surfer
 - RDFRENSD - Read tropical Atlantic French cruise data
 - RDFRSDBA - Read tropicl Atl. French cruise data (batch)
- ENVIROANAL**
 - GRIDANL**
 - GEMPLOT - Create graphics overlay of environmental data
 - TIMENV - Generate time series from environmental data
 - ENVIMG - Create image from environmental data
 - GRDMEAN - Compute stats for blotch area on gridded img
 - ASCTTRANS - Create Surfer ASCII file from CDF
 - UNGRIDANL**
 - PLOTLOC - Plot station locations on image
 - DRIFTER - Drifter track analysis and plotting
 - EDTDRIFT - Edit drifter track ASCII file
 - BINDRIFT - Compute gridded stats from drifter data
 - DENS_PROF - Comp. dens., Brunt-Vaisala freq. from profiles
 - MEAN_PROF - Generate mean hydrographic ASCII profile
 - UTILANL**
 - TOHP - Sends graphics file to HP plotter
 - TOTEK - Sends graphics file to TEK terminal
 - GPKILL - Kill GEMPLT subprocess
 - SWITCHG - Access GEMPAK programs from SEAPAK
 - SWITCHS - Re-access SEAPAK programs after running GEMPAK

- DEMOS
 - PROGDEMO
 - CZCSPROG
 - PROG1 - SEAPAK programs demo 1
 - ANCPROG
 - DRIFT - Drifter data program
 - PRODDEMO
 - SOCEAN - Southern Ocean products
 - SR1988 - 1988 site review, ancillary data
 - SR1989 - 1989 site review, CZCS/ancillary data
 - CZCS - CZCS products
 - CZCSBRF - CZCS products (brief version)
 - DATA - Ancillary data products
 - DATABRF - Ancillary data products (brief version)
 - ARABIA - Interannual variability in Arabian Sea region

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16. Abstract In the 2 years since the publication of Version 1.0 of the SEAPAK User's Guide, significant revisions to the CZCS and AVHRR support and statistical data analysis module have been made and the ancillary environmental data analysis module has been greatly expanded. SEAPAK now has about 200 procedures in the menu. The package continues to emphasize user-friendliness and user-interactive data analyses. Additionally, because the scientific goals of the ocean color research being conducted have shifted to larger space and time scales, batch processing capabilities for both satellite and ancillary environmental data analyses have been enhanced, thus allowing large quantities of data to be ingested and analyzed in background. The continued development of SEAPAK has been paralleled by three other activities that have been influential and assistive: the global CZCS processing effort at GSFC; the collection of oceanographic data sets at NCDS; and the development of PC-SEAPAK. SEAPAK incorporates the final instrument calibration and supports all levels of data available from the CZCS archive. Volume II of the SEAPAK User's Guide contains descriptions of programs.					
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